AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

EDMC#:	0057518
SECTION:	2 OF 2
DOCUMENT #:	RPP-10435, REV 000
TITLE:	Single-Shell Tank System Integrity Assessment Report

APPENDIX E

SINGLE-SHELL TANK INTEGRITY EXAMINATIONS

Prepared by: F. G. Abatt — F. G. Abatt Date: 6/10/02

Reviewed by: L. J. Julyk — L. J. Julyk Date: 6/10/02

L. B. Munnell — L. B. Munnell Date: 6-10-02

This page intentionally left blank.

TABLE OF CONTENTS

FIGURES

This page intentionally left blank.

APPENDIX E

SINGLE-SHELL TANK INTEGRITY EXAMINATIONS

E1.0 OBJECTIVE

This appendix supports, in part, the requirements set forth in paragraphs A and E of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-23-24, "Submit Single-Shell Tank Integrity Assessment Report and Associated Certification(s) and Determination(s) Pursuant to 40 CFR 265.191." The milestone requires that the assessment report shall document the results of leak tests, internal examinations, and visual examinations by direct observation or remote camera surveillance within each single-shell tank (SST). In this appendix, the results of internal visual inspections and dome elevation survey data for the SSTs are summarized. Results from this appendix, in combination with other appendices, are used in assessing the current structural integrity and useful life of the SSTs with respect to their ability to maintain a stable configuration to resist internal and external loads until final closure. Leak tightness of SSTs is addressed based on tank liquid level measurements reported in this appendix and leak history data summarized in Appendix D.

E2.0 APPROACH

Historical in-tank photographs and videotapes as well as results of periodic dome elevation surveys are reviewed for each of the 149 SSTs. Although visible portions of the SST liners are included in the photographs and videotapes, the focus of this review is on assessing the structural condition of the exposed concrete dome regions of each SST. In-tank photographs and videotapes are reviewed for evidence of concrete degradation; that is, concrete spalling, cracks, exposed rebar, concrete staining from rebar corrosion, or other anomalies. Dome elevation survey data is reviewed for evidence of unexplained anomalous trends in dome displacement that exceed the established screening criterion. The results of a scale model structural test of a Hanford SST are introduced in Section E5.0. The results of the test provide guidance for the identification and interpretation of the physically observable signs of structural distress on a tank dome. Leak testing and monitoring of the SSTs is also reviewed.

E3.0 CONCLUSIONS

- In-tank visual surveillance indicates that the overall structural condition of the visible concrete in the SSTs is sound.

- Visual surveillance indicates that minor imperfections or degradation are present in the dome concrete of some of the tanks. Construction photographs show that some minor imperfections existed at the time of construction. There is no evidence that any of the observed imperfections or local areas of degradation have affected the overall structural stability of the tanks.

- Visual examinations of the tank interiors have not shown any obvious and extensive visible cracking in the dome concrete that might be associated with tank settlement, and the dome elevation survey measurements have remained stable. Thus, the available data support the conclusion that any structural degradation that may have occurred in the tank footings and base has not significantly affected the overall structural stability of the tanks.

- The videotapes of tanks C-104 and C-106 show clear evidence of local concrete damage around the 36-inch risers. The damage may be the result of a riser retrofit installation. The local concrete damage does not significantly affect the overall strength of the dome.

- Patterns that may indicate concrete degradation are visible in a 1996 videotape for tank AX-104. These patterns are not visible in the 1983 still photographs of the tank, although the location of the images may not be the same. Because the image quality of the videotape is not as good as many of the still photographs, it is difficult to make a definitive judgment regarding the cause or extent of any degradation associated with the markings, but the videotape shows no direct evidence of exposed rebar or rebar corrosion.

- Based on the review of the dome elevation survey data for the 100-series tanks and the reasonable value set for the acceptable limit, the elevation survey data do not indicate any signs of structural distress on any of the tanks. Due to the structural configuration of the 200-series tanks, elevation surveys are not necessary for these tanks.

- Degradation of the concrete near the bottom of the tanks may still be occurring, but due to the inaccessibility of the concrete, the degradation cannot be directly confirmed or quantified by current in-tank visual surveillance and dome elevation survey methods.

- Some photographs and videotapes show the visible portions of the tank liners to be in very satisfactory condition with very little apparent corrosion. In other cases, signs of corrosion are visible, but the liners appear to be intact. The degree and extent of corrosion of the steel liners is difficult to ascertain from the photographs and videotapes.

- There is no leakage detected for seven 200-series tanks with liquid level monitoring. The 100-series tanks cannot be adequately leak tested because of their size (75 foot diameter) and the confounding effects of temperature variations, pressure variations, tank end deflection, vapor pockets, salt precipitation, and evaporation.

E4.0 INTRODUCTION

In-tank photography and dome elevation survey data are extremely valuable because they act as an "early warning system" to detect signs of structural distress of the tank concrete, especially when used together. A major advantage of visual observations of the concrete relative to predictive degradation models is that unanticipated degradation of the concrete can generally be detected even if it cannot be predicted.

Visual inspection is a useful tool for assessing the condition of dome concrete because most degradation mechanisms manifest themselves in the cover concrete. The photographs and videotapes also show many good images of the steel liners. Some images show the visible portion of the liners to be in very satisfactory condition, and some images show visible signs of corrosion on the liners. The images generally do not have enough resolution to detect small pits in the liners (except when evident by signs of asphalt intrusion). Some semi-quantitative information on uniform corrosion can be inferred by the fact that unlike the liner itself, the liner stiffener rings are exposed to waste on both sides. This means that the general thinning of the stiffeners progresses at twice the rate of general liner thinning. The fact that the stiffener rings are still intact provides some information on the extent of uniform corrosion of the liner.

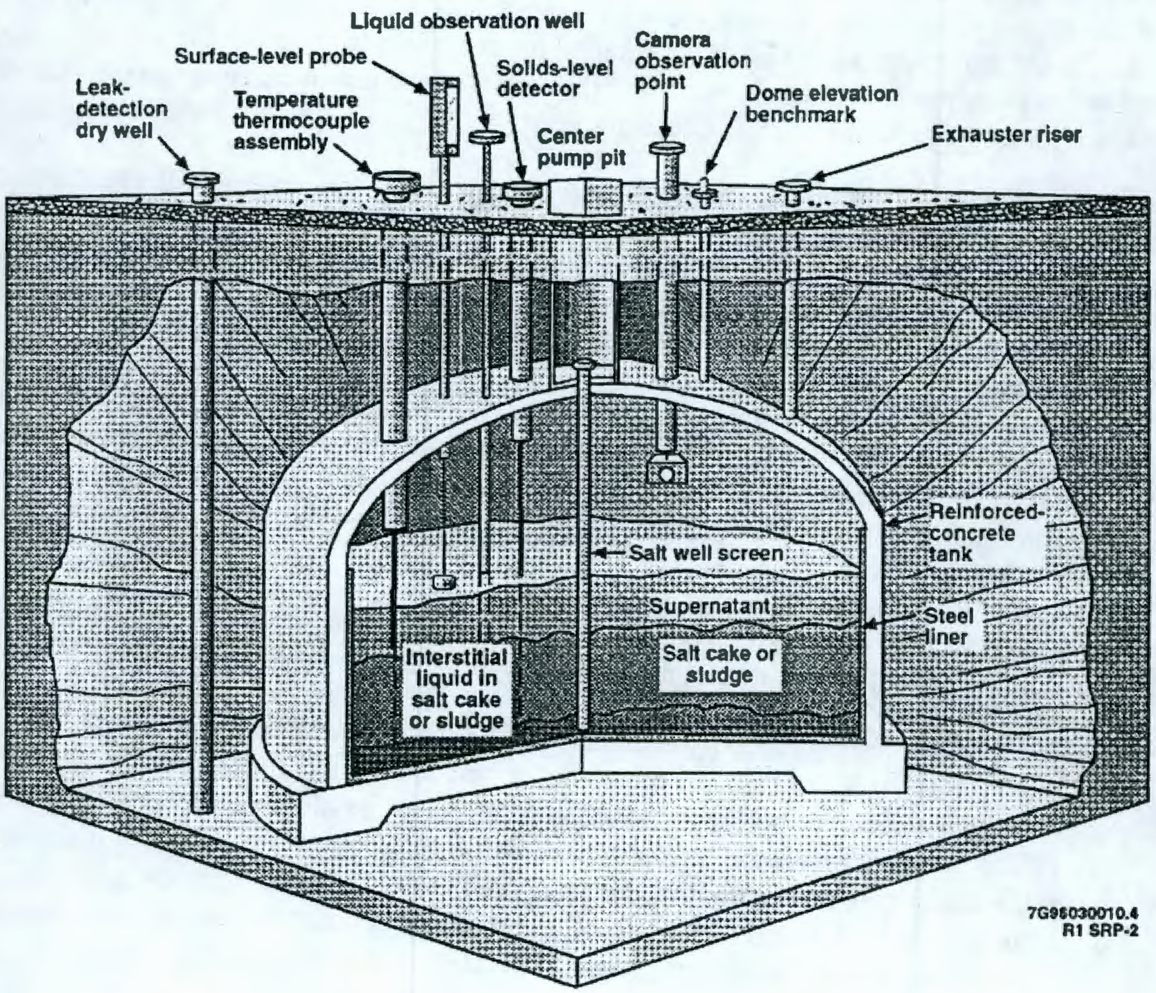
Although the images do provide useful information on the general condition of the liners, they are not an especially effective tool for quantifying the extent or severity of existing corrosion. Moreover, dome elevation survey data provide little if any information regarding the condition of the tank liners. Consequently, the focus of the visual examinations and dome elevation survey data is on the structural integrity of the concrete tanks and not on the functional integrity or leak-tightness of the liners. Leak testing and monitoring is discussed in Section E8.0.

The most direct and reliable method of determining whether any significant degradation of the tank concrete has occurred is remote visual observations and dome elevation survey data. The only portion of the tank concrete that is visible during in-tank visual surveillance is the interior surface of the tank dome. However, the concrete dome is the critical portion of the tank structure from the point of view of overall structural stability, and early signs of structural distress will be visible in the dome concrete. Signs of degradation in the walls and base of the tank concrete may appear indirectly as cracks in the dome concrete or in unusual dome elevation measurements.

Earlier observations and measurements including construction photographs serve to establish a baseline condition for the tanks, which is critical in determining if active degradation mechanisms are present. Subsequent surveillance of the tanks can then be used to help determine if changes in the tank concrete are occurring relative to a baseline condition. The establishment of a baseline condition is also an important tool for understanding any unexplained or difficult to identify anomalies that are observed. The cause of anomalies or apparent discontinuities in the dome concrete may be difficult to identify visually because of limitations on lighting or inherent limitations of the videotaping or photographic equipment. Some cracks, imperfections, or unidentified anomalies may have existed for a long time and may be passive, while some may have appeared later and may be active (i.e., increasing in extent or severity with time). The existence of a baseline condition of a tank provided by a visual record of the condition of the tank domes over time can provide valuable information on the evolving condition of the structure. Direct comparison of inspection results from two different times in the life of the structure is useful in demonstrating structural reliability. Thus, even though it may be impossible to identify the specific cause of a crack or area of degradation, it is very helpful to know whether the condition is changing with time. With the possible exception of some unusual patterns observed on the dome concrete of tanks AX-104 and BY-110, the visual surveys and dome elevation data have not shown any signs of evolving degradation of the tank concrete.

To aid the reader with some of the terminology used in this appendix and to help visualize the configuration of an SST, a cutaway view of a typical 100-series Hanford SST is shown in Figure E.1.

Figure E.1. Cutaway View of Typical 100-Series Hanford Single-Shell Tank



E5.0 STRUCTURAL TEST OF 1/10 SCALE MODEL OF HANFORD SINGLE-SHELL TANK

In 1968 and 1969, a scale model test of a Hanford SST was performed by Wiss, Janney, Elstner and Associates of Northbrook, Illinois for the Atlantic Richfield Hanford Company (ARH 1969). The model was based on the design of tank A-105, which is a 75-foot-diameter SST (100-series) with a nominal capacity of 1 million gallons. The scale model was geometrically similar to the prototype with linear dimensions 1/10 that of the prototype. The objectives of the scale model tests were to determine the structural effects of dome perforations (penetrations simulating riser locations) on the ultimate load capacity of the structure, and to investigate the overall behavioral performance of the tank as indicated by strains, displacements, stresses, and cracking.

The scale model test was important because it is the only structural test designed to test the ultimate load capacity of a Hanford concrete tank subjected to structural and thermal loads. The model was supported on a circular concrete girder and it did not include the base slab that is present in the prototype tank. The only structural loads applied to the model were simulated soil overburden loads applied to the dome. Thus, the results of the test do not provide information on the behavior of the tank base slab and footings.

The data from the scale model test supplement the analytical understanding of the behavior of the tank as it is loaded to its ultimate capacity. The observations made during the test can help focus the goals of an integrity examination program on physically observable signs of structural distress. The results of the scale model test, in combination with supporting structural analyses, led to the following conclusions regarding physically observable signs of structural distress:

- Observable meridional cracks on the inside surface of the dome emanating from the haunch region of the tank and progressing toward the center of the dome are an effective early indicator of structural distress of the dome and should be visible at load levels well below the ultimate load capacity. See Figure E.2 for a graphical depiction of crack terminology.

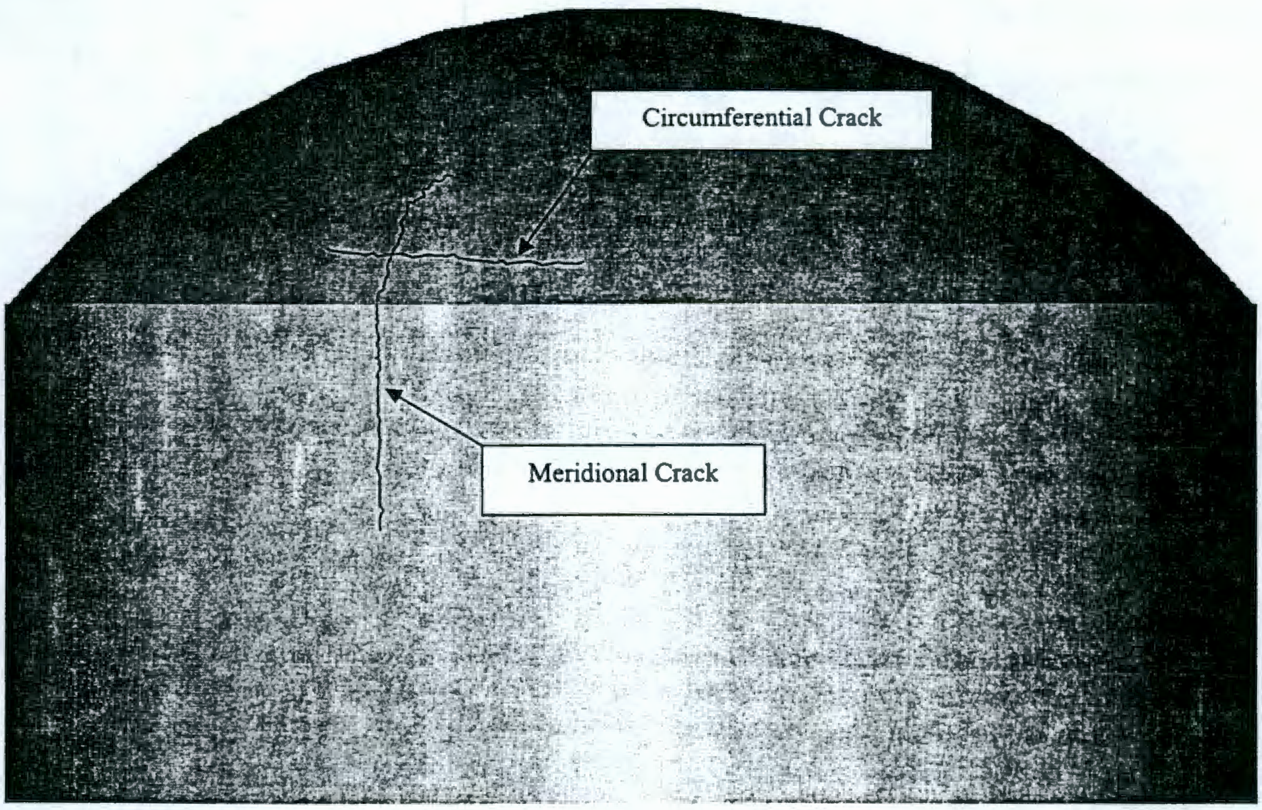
- Conversely, absence of the type of visible crack patterns described above is a strong indication that the tank domes are not in danger of imminent failure.

- Based on the results of the scale model test and the structural analysis reported in Julyk (1994), it is predicted that an initial downward dome deflection of 0.3 to 0.5 inch would have occurred before the baseline dome elevation measurements taken in the early 1980s. If one assumes the higher initial downward dome deflection of 0.5 inch occurred at the dome apex before the first dome elevation measurement, then an additional deflection of 0.24 inch (corresponding to the specified dome deflection limit) results in a total deflection of 0.74 inch. According to results presented in Julyk (1994), this deflection corresponds to a dome load that is approximately 40% of the predicted collapse load.

- According to both ARH (1969) and Julyk (1994), a total deflection at the dome apex of approximately 1.5 inches corresponds to the beginning of nonlinear load-deflection response and the transition to the nonlinear range occurs at approximately 70% of the ultimate load.

- Dome deflection data can be an effective early indicator of structural distress of the SSTs when used in combination with all other available data.

Figure E.2. Graphical Depiction of Crack Terminology



E6.0 VISUAL EXAMINATIONS

Visual surveillance of the tank interiors has been performed using both still photography and videotape. A review of in-tank surveillance using each of the above methods is presented in the next two sections. The in-tank visual surveillance indicates that the overall structural condition of the dome concrete is sound. The surveillance also shows that the visible portions of the tank liners are intact though signs of corrosion are evident in varying degrees.

E6.1 REVIEW OF IN-TANK PHOTOGRAPHS

A large collection of in-tank still photographs exists covering all 149 SSTs. The majority of the still photographs were taken between 1970 and 1990. In most cases, there are more than one series of photographs taken at different times for each tank. Nearly 4,000 photographs were reviewed during the preparation of this appendix. The resolution of the digital images of the still photographs varies depending on the resolution at which the negatives were scanned. In general, the scanned images of still photographs are of significantly higher quality than the videotape images. In many cases, the quality of the still photographs is remarkably good.

At the time that this appendix was prepared, not all known in-tank photographs had been digitized, so some in-tank photographs that are known to exist were only available as negatives and were not included in this review. Dates of the most recent in-tank photographs are listed in Hanlon (2002).

Although not all known photographs of the tanks were reviewed, representative photographs were reviewed for all 149 SSTs. The photographs include many good images of the dome concrete and the walls of the steel liners. Due to the large number of good quality photographs, the extensive coverage of the photographs, and the significant time period over which the photographs were taken, the images that were reviewed provide a meaningful and broad-based representation of the condition of the visible portion of the SSTs.

Many of the images of the concrete show what appears to be staining or streaking patterns. The patterns may be due to the surface coating on the concrete or to asphaltic materials used during construction. The patterns may also be caused by waste condensate or rust stains from the risers. Evidence of abandoned concrete formwork accessories embedded in or adhering to the underside of the domes was observed in a few tanks, but this is does not affect the strength or durability of the domes.

A number of in-tank photographs show evidence of asphalt that has run down the inside of the steel liners. Asphalt was used during construction as part of a three-ply asphaltic membrane applied to the outer surface of the liners. The membrane extends over the top of the liner and continues underneath the lead flashing at the top of the liner. In some cases, asphalt appears to emanate from the flashing level. However, there are also images that show the asphalt emanating from what appear to be pits or perforations in the tank liners below the level of the flashing. Images of asphaltic material on the tank liners appear in photographs of tanks BY-107, BY-110, S-102, and TX-114, among others. This phenomenon was observed in photographs of tank BY-110 taken in 1969, and the observations prompted a study that is reported in ARH (1972). The following conclusions were presented in ARH (1972):

1. The tar leaks were the result of a liquid-air interface corrosion phenomenon that occurred at prior liquid levels.

2. Interface corrosion can occur in less than six months, but may not occur at all.

3. Waste identity in storage tanks is sufficiently masked through mixing by numerous transfers that correlation of corrosion with waste type is not possible.

4. Tar leaks into the tanks do not necessarily mean that waste has leaked out; in fact, the flowing tar should tend to plug any hairline cracks in the concrete.

It is stated in Appendix A that the asphalt on the outside of the liners and under the grout pads beneath the liners begins to soften in the temperature range of 83 to 315 °F depending on the type of asphalt. It is also stated that the asphalt probably liquefied in the lower side walls and on top of the base mat in the hotter tanks. The softened asphalt may tend to plug small leaks in the tanks and may be one reason why leak volumes have not been correlated with high temperatures.

E6.2 REVIEW OF VIDEOTAPES

The videotapes of the tank interiors were taken between 1993 and 2001. The number of in-tank videotapes is much less than the number of still photographs, and not all tanks interiors have been videotaped. The initial screening of the videotapes to be reviewed was based on applicability, quality, redundancy, and availability. Some tapes resulting from the database search were clearly not applicable to the present task and were not reviewed. Examples of tapes in this category are tapes of double-shell tanks and tapes that based on the title would clearly not show the tank interiors. Of the tapes reviewed, many were not useful for a structural assessment because they did not show the tank interior, or because the quality was too poor to make any assessment. Also, not all videotapes believed to exist are retrievable through a database search. In some cases, older tapes of a particular tank were not reviewed if more recent videotapes showing the general condition of that tank were available and were of sufficiently good quality to determine the general condition of the tank. The screening process resulted in the review of 42 videotapes of varying quality that showed useful images of the tank interiors. The 42 videotapes covered the following 36 tanks:

- A-102, A-104, A-105
- AX-103, AX-104
- BX-110
- BY-103, BY-104, BY-105, BY-108, BY-110
- C-103, C-104, C-106, C-107, C-201, C-202
- S-102, S-110, S-111, S-112
- SX-103, SX-104, SX-105, SX-106, SX-115
- T-103, T-106, T-107, T-111

- TX-107, TX-113
- U-101, U-102, U-107, U-109.

Based on the review of the photographs and videotapes, only tanks C-104 and C-106 show clear evidence of concrete damage. The images show missing concrete and exposed reinforcing steel in a local area around the 36-inch risers in tanks C-104 and C-106. According to Drawing H-2-41370, "Structural Construction Sequence - Pump Pit," these risers were installed through an access way opening in the concrete dome after the dome concrete had been placed. The damage to the concrete around the risers may be the result of the riser retrofit installation. This concrete damage is local and does not affect the overall strength of the dome.

Still photographs of tank AX-104 taken in 1983 show the dome concrete to be in generally good condition with possible minor local degradation. Patterns that may indicate concrete degradation are also visible in the 1996 videotape for tank AX-104. In some places, the patterns seen in the 1996 videotape are irregularly shaped, but in other places, the patterns appear regular and may coincide with the locations of the dome reinforcing steel. These patterns are not visible in the 1983 photographs, although the location of the images may not be the same. It is difficult to interpret the markings due to the poor quality of the images, but the 1996 videotape images raise questions as to the nature of the markings. The videotape shows no obvious evidence of exposed rebar or rebar corrosion.

Concrete surface discolorations that appear in a patchy regular pattern were observed in a videotape of tank BY-110 taken in June 1995. The discolorations are visible in a localized area of the concrete well above the haunch region. The regular pattern of the discolorations suggests that they may be related to the location of the dome reinforcing steel. The pattern may also be related to the surface coating of the concrete or to deposits from waste condensate. Because of the limited quality of the videotape image, the cause of the discoloration cannot be determined from the videotape images. However, the present condition of the concrete appears sound.

E7.0 REVIEW OF DOME ELEVATION SURVEY DATA

A review of dome elevation survey data is presented in this section. The conclusion of the review is that the elevation survey data for the 100-series SSTs do not indicate any signs of structural distress on the tanks.

Dome elevation surveys have been performed on the 100-series SSTs since the late 1970s. Survey measurements have not been taken on the 200-series SSTs, but the structural configuration of these tanks is significantly different than the 100-series tanks. The roof structure of the 20-foot-diameter 200-series SSTs is a complex structure composed of a 1-foot-thick reinforced concrete flat roof slab integrally connected both to the tank side wall and to a massive reinforced concrete pit that extends from the roof to approximately 1 foot above grade. This massive reinforced concrete pit, which originally housed two condenser units, covers a large portion of the roof, limiting the soil loading area to about half the roof area. Although the roof must support 11 feet of soil overburden and its own self-weight, the integrated reinforced concrete roof and pit structure has a high capacity for vertical loads. In addition to an increased resistance to roof deflections, the 200-series SSTs do not have air lift circulators or other equipment suspended from the roof. Thus, there is no potential for loads to be transmitted to the roof structure by waste buildup on suspended equipment, as is the case for some 100-series SSTs. Finally, the 200-series SSTs were not exposed to high temperatures experienced by some of the 100-series SSTs. Hence, only the 100-series SSTs were required to be periodically monitored for signs of potential dome overload, particularly during salt well pumping of 100-series SSTs that had air lift circulators or other dome suspended equipment that could accumulate waste deposits.

The earliest dome elevation survey data available is for tank SX-101 and dates back to 1979. The elevation survey data for all other tanks in the SX farm (tanks SX-102 through SX-115), as well as for all tanks in the S and T farms began in 1980. Elevation surveys for the TX farm began in 1981, and survey data for the BX and BY tank farms date back to 1983. The earliest survey data from the A, B, AX, C, TY, and U farms is from 1984. By November 1980, all of the SSTs were removed from service, that is, no additional waste was received and no transfers were made except for removing liquids. Thus, the vast majority of the dome elevation survey data has been collected after the tanks were removed from service. Although dome elevation measurements have not been correlated to environmental or tank operational variables, the measurements are useful for monitoring and predicting the structural integrity of the tank domes.

The survey measurements are made directly on risers, on concrete pits anchored to risers, on concrete pads, or on concrete monuments. The pads and monuments are not generally attached to the tank dome via a riser, and thus these measurements do not provide as direct an indication of the dome elevation as measurements directly on risers, or on pits attached to risers.

The Operating Specifications Document OSD-T-151-00013, *Operating Specifications for Single-Shell Waste Storage Tanks*, states that dome deflection surveys shall be conducted at least every 24 months plus or minus 2 months, except that surveys shall be conducted every 12 months plus or minus 1 month for tanks containing dome suspended airlift circulators, or when required during jet pumping (OSD 2000). The procedure for conducting dome elevation surveys calls for first making measurements of fixed control monuments that are located in the tank farm, but are not above the tanks. As a check on the stability of the monuments, the elevation of two control monuments is determined before making dome deflection surveys. The elevation of the benchmarks on the tank risers is then determined relative to the elevation of the control monuments. Based on the precision of the survey instruments and the surveying procedure, the overall accuracy of the survey measurements is approximately 0.002 foot.

Changes in elevation measurements can indicate deflections in the tank dome or overall settlement of the tank structure. In the case of benchmarks on monuments and pads that are not attached to the tanks, changes in elevation could simply indicate a movement of the benchmark relative to the tank. Proper correlation of the elevation survey data with the structural behavior of the tank depends on the general trend of all benchmarks elevations on a tank, the location of each benchmark, and whether the benchmark is attached to the tank. Overall settlement of several benchmarks on a tank will tend to indicate general tank settlement. Dome deflections are indicated by the relative displacements between benchmarks at different radial distances from the apex of the dome. The behavior of the dome is more important to the structural stability of the tank than overall settlement of the tank. Because the inaccessibility of the tanks limits the amount of information from any single surveillance method, the dome elevation survey data is best used in conjunction with the results of visual surveys of the tank interiors to help assess the condition of the structure. To help understand the history of the survey procedure, the Fluor Federal Services Survey Supervisor provided the following brief history and description of the surveying process.

> In some cases, these studies [dome elevation surveys] were being performed in the late 1970's. The results have been compiled in a running summary report. We have the results of the early surveys, but not the field notes. So verifying the early results or explaining errors is only conjecture. In March of 1986 we adopted a process that is still used today. In general, the process requires that we use certain survey equipment that is verified to be in good adjustment. We start by checking between two primary benchmarks, in each farm, to verify neither has been disturbed. Then we run a secondary level circuit to a benchmark on each tank, checking back into the primary benchmarks. Then we run a level circuit from the secondary benchmarks to the other benchmarks on that individual tank. This process allows us to verify that each circuit is precise and keeps errors from building up.
>
> If we detect a difference of over 0.01 feet, at any benchmark, we are required to perform the work again, to verify precision. If we detect a difference of over 0.02 feet, we are required to report that to the Tank Farm shift manager for immediate evaluation.
>
> Most of the data that looks erratic was obtained prior to March, 1986. Many of the benchmarks that have been noted as disturbed are still being reported relative to their original elevations. The disturbed benchmarks should be re-baselined or "zeroed" so their cumulative differences are representative. This can be done with concurrence of the Tank Farm operator (CH2M HILL).

Relative to the initial baseline measurement, the riser elevation surveys typically show variations from the baseline values on the order of hundredths or thousandths of a foot. A maximum allowable decrease in the dome elevation of 0.02 foot (0.24 inch), relative to the baseline measurement, has been specified in OSD (2000) as the acceptable limit for SSTs. The basis for the specified limit is included in RHO (1985). Based on prior structural analysis and scale model testing, the limit specified in OSD (2000) appears to be a reasonable value for detecting early signs of structural distress in the tank dome.

The survey data were originally entered and kept in field survey notebooks. The data were later transcribed into electronic spreadsheets on a tank-by-tank basis. In support of this integrity assessment, the electronic spreadsheet data were plotted for each of the 100-series SSTs, and the plotted data were reviewed for any signs of structural distress. The initial review of the plotted data showed that the vast majority of measurements were within the limit and that the measurements were generally stable over time. However, the initial review also showed a few measurements that appeared to be erratic, or that approached or exceeded the specified limit.

E7.1 INVESTIGATION OF ANOMALOUS SURVEY MEASUREMENTS

There are several reasons that may explain the anomalous behavior observed in a few measurements during the review of the preliminary data. In addition to the possibility that the measurements are reflecting changes in dome elevation, other reasons for anomalous measurements include survey error, notebook entry errors, arithmetical errors, transcription errors, and disturbed benchmarks that were not accounted for in the survey data.
The measurements that appeared erratic were selected for additional review to determine the reasons for the behavior.

The first step in the review process was to examine the "raw" spreadsheet data for any signs of obvious errors or any notes that would explain the anomalous measurements. The second step was to review the original survey data and field notes for additional information or signs of obvious errors. The Survey Supervisor for Fluor Federal Services performed the review of the original survey data and field notes.

The review of the "raw" spreadsheet data indicated a few instances of obvious errors in data entry or data summation. When such errors were discovered, they were corrected in the spreadsheets. The review of the spreadsheet data also turned up several instances of notes in the spreadsheet indicating that benchmarks had been disturbed. When this is the case, the benchmarks should be re-baselined. This was not explicitly done with the initial spreadsheet data, and thus the preliminary survey data show a drop in elevation that reflects a disturbed benchmark rather than a change in dome elevation. In one case, there was a note in the spreadsheet that the surveyors were unable to get a reliable measurement because a benchmark was partially blocked. However, multiple benchmarks are provided on each tank and at least two benchmarks must be available for a survey.

The review of the original survey data and field notes revealed additional notes indicating disturbed benchmarks. In some cases, the notes were not transcribed to the electronic spreadsheets. After reviewing all available survey data, there were instances of anomalous measurements for which no additional information was found. Generally, the erratic measurements for which no additional information was located occurred before March 1986. This is an important date because the survey process was improved in March 1986 (KEH 1986). As a result of the survey process improvement, the measurements taken after March 1986 are considered to be more accurate and less subject to survey error. In other words, survey data before March 1986 are simply less reliable and the field notes are incomplete.

Most of the anomalous measurements are the result of simple mistakes or disturbed benchmarks. Also, some early survey data were erratic and inconsistent, but improvements in the survey procedure have minimized errors and increased the reliability of the data. There are two cases of anomalous measurements occurring since March 1986 for which no additional information was available. These two cases were the 1986 and 1988 measurements on riser #6 on tank A-105 and the 1986 measurement of the monument riser on tank B-111. In such cases it is instructive to look at the long-term behavior of the benchmark elevation as well as the elevation data for the other benchmarks on the same tank. In both of the above cases, a single benchmark measurement approached or exceeded the specified limit on one or two occasions, but returned to more normal readings in subsequent measurements. Moreover, the other benchmarks on each tank were stable and within the specified limit. It is highly unlikely that dome settlement indicative of structural distress could occur without it being reflected on more than one benchmark.

Dome elevation data must be considered in conjunction with all other available data including in-tank visual surveillance, operating history, leak status, and supporting analyses.
The photographs and videotapes have not shown the crack patterns that are an early warning sign of structural distress. The absence of the crack patterns is a strong indicator that the tanks are not in danger of imminent failure. Thus, the anomalous measurements observed in the preliminary data do not appear to indicate structural problems with the tanks. Although the results of integrity examinations support the conclusion that the tanks are structurally stable, degradation of concrete at the base, footing, and lower wall of the tanks may continue to occur.

E8.0 SINGLE-SHELL TANK LEAK TESTING AND MONITORING

This section discusses SST system leak testing and presents the results of these tests as specified by *Hanford Federal Facility Agreement and Consent Order* Milestone M-23-24. A leak test or other integrity examination is required by 40 CFR 265.191 to show the tank is not leaking. To date, 67 of the 149 SSTs have been declared confirmed or assumed leakers. The leak history of the SSTs and leak status is discussed in Appendix D.

During construction, the four tanks in the AX farm were hydrostatically tested to verify the leak integrity of the carbon steel liner. All weld seams in A, AX, and SX farm tanks were vacuum-box tested. Weld seems in all of the remaining SSTs were radiographed (Appendix A). Currently, tanks are leak monitored as described in RPP-9645 (Barnes 2002).

The requirement per the regulation (40 CFR 265.191) is, "the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects." The degree to which these effects must be taken into account is suggested by an U.S. Environmental Protection Agency policy directive (OSWER 1986) which expects "leak tests that are as accurate as the state of the art will allow and are in conformance with good safety practices." Although a standard is not provided, the policy directive lists testing technologies under review, including the technique of sensing the change of weight of a submerged object to measure the liquid level. This technique is in the group of listed techniques that are the most accurate. The same technique is used in the SSTs with a liquid surface (Barnes 2002).

For the SSTs it has been found by experience that the uncertainty in the effects of temperature variations, pressure variations, tank end deflections, vapor pockets, salt precipitation, and evaporation mask small level changes that are caused by small leaks (Johnson 1995). These confounding effects are magnified in the 100-series tanks (75 foot diameter).

Leak tests should be able to detect leaks of 1.0 to 0.05 gallons per hour. Using this leak detection target for the large-diameter tanks requires that the leak tests be conducted over a long to unreasonably long time (years). However, for the 200-series tanks (20 foot diameter) with a monitored liquid surface, it is possible to conduct a leak test over a reasonably short time (weeks) using the level monitoring instrumentation currently in use in these tanks.

There are 16 200-series SSTs. Seven are assumed leakers, two are not monitored for liquid level, and the remaining seven tanks have a monitored free liquid surface (B-202, T-201, T-202, T-204, U-201, U-202, U-204). A review of the liquid level histories for these tanks from August 2001 to February 2002 shows no measurable change in the liquid level, which demonstrates these seven tanks are not leaking.

Although the 100-series tanks cannot be adequately leak tested, the U.S. Department of Energy's current effort to remove all pumpable liquid from the SSTs by September 2004 will reduce, if not eliminate, the amount of additional waste that could enter the soil which in turn reduces the need for a leak-tight tank.

E9.0 REFERENCES

ARH-R-47, 1969, *Model Tests of Waste Disposal Tanks*, prepared by D. McHenry and O. C. Guedelhoefer, Wiss, Janney, Elstner and Associates, Northbrook, Illinois for Atlantic Richfield Hanford Company, Richland, Washington.

ARH, 1972, *Review of Storage Tank Integrity*, ARH-1496, prepared by W. L. Godfrey, Atlantic Richfield Hanford Company, Richland, Washington.

Barnes, D. A., 2002, *Single-Shell Tank System Surveillance and Monitoring Program*, RPP-9645, February 2002, CH2M HILL Hanford Group, Richland, Washington.

Hanlon, B. M., 2002, *Waste Tank Summary Status Report for Month Ending February 28, 2002*, HNF-EP-0182, Rev. 167, Prepared for the U.S. Department of Energy by CH2M HILL Hanford Group, Inc., Richland, Washington.

Julyk, L. J., 1994, *Tank 241-C-106 Structural Integrity Evaluation for In situ Conditions*, WHC-SD-W320-ANAL-001, Rev. 0 and 0A, Westinghouse Hanford Company, Richland, Washington.

Johnson, M. G., 1995, *Technical Bases for Leak Detection Surveillance of Waste Storage Tanks*, WHC-SD-TI-573, Rev. 1, February 1995, Westinghouse Hanford Company, Richland, Washington.

KEH, 1986, Kaiser Engineers Hanford Company Letter from G. F. Brazil to Scott Lewis of Rockwell Hanford Operations, *Subject: Waste Tank Dome Elevation Survey Program*, Dated March 12, 1986, File # 2EBF-004.

OSD, 2000, Tank Farms Operating Specifications Document, *Operating Specifications for Single-Shell Waste Storage Tanks*, OSD-T-151-00013, Rev. D-18, Dated November 9, 2000.

OSWER, 1986, *Technical Resource Document for the Storage and Treatment of Hazardous Waste in Tank Systems*, OSWER Policy Directive No. 9483.00-1, prepared for U.S. Environmental Protection Agency, Washington, D.C.

RHO, 1985, *Technical Bases for Single-Shell Tank Operating Specifications*, SD-RE-TI-035, Rev. 1, prepared by E. V. Weiss, Rockwell Hanford Operations, Richland, Washington.

APPENDIX F

SINGLE-SHELL TANK MATERIAL COMPATIBILITY

Prepared by: F. G. Abatt Date: 6/10/02
F. G. Abatt

E. B. Schwenk Date: 6/10/02
E. B. Schwenk

J. E. Meacham Date: 6/10/02
J. E. Meacham

Reviewed by: R. P. Anantatmula Date: 6/10/02
R. P. Anantatmula

This page intentionally left blank.

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF TERMS

mpy	mils per year
PCA	Portland Cement Association
PUREX	plutonium-uranium extraction
REDOX	reduction oxidation
SAE	Society of Automotive Engineers
SCC	stress-corrosion cracking
SRS	Savannah River Site
SST	single-shell tank
TBP	tributyl phosphate

This page intentionally left blank.

APPENDIX F

SINGLE-SHELL TANK MATERIAL COMPATIBILITY

F1.0 OBJECTIVE

This appendix supports in part the requirements set forth in paragraphs A, B, and C of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-23-24, "Submit Single-Shell Tank System Integrity Assessment Report and Associated Certification(s) and Determination(s) Pursuant to 40 CFR 265.191." Specifically, the compatibility of stored waste with the materials of construction is addressed. Results of this appendix, in combination with the results from other appendices, are used to assess the structural integrity, functional integrity, and the useful life of the single-shell tanks (SSTs).

F2.0 APPROACH

This appendix presents the results of experimental programs that were conducted to determine the potential for liner corrosion and concrete degradation caused by contact with or thermal effects resulting from the contained waste. The appendix is organized into three main sections. The first section describes corrosion testing performed to determine the effects of tank waste on the steel liner. The second section describes testing to determine the effects of tank waste on the reinforced concrete. The third section describes the behavior of concrete at elevated temperatures associated with the tank waste. The results of the three sections are integrated with results of the integrity examinations discussed in Appendix E to draw conclusions about the structural and functional integrity of the SSTs. Corrosion protection measures used on the tanks are described in Appendix A.

F3.0 CONCLUSIONS

The following conclusions of this appendix are based on a combination of experimental data, experience, and the results of the integrity examinations that are discussed in Appendix E.

- In spite of the inherent uncertainties in extrapolating early short-term corrosion test results to long-term in-service conditions, the test results are generally consistent with observed perforations in some tank liners.

- Pitting corrosion in the vapor space above the waste surface led to perforation of some tank liners consistent with the laboratory test data. Some of the high temperature tanks experienced breaches of the tank bottoms due to a combination of bottom bulging and corrosion-induced liner degradation.

- Because some of the Hanford SSTs have leaked, portions of the concrete of these tanks have been exposed to tank waste. Exposure to tank waste will degrade SST concrete. The amount of degradation will increase with increased exposure to tank waste and increased temperature, and degradation of the concrete near the bottom of the tanks may still be occurring.

- The degree of concrete degradation caused by such exposure to tank waste is difficult to quantify because the lack of access to the bottom of the tanks precludes a visual inspection. However, as discussed in Appendix E, the results of integrity examinations support the conclusion that any structural degradation that may have occurred in the lower portion of the tanks has not yet significantly affected the overall structural stability of the tanks.

- Decreased waste temperatures have decreased the aggressive corrosive activity of the waste toward both the steel liner and the concrete tank. The long-term slow increase in corrosion-inhibiting chemical species, also acts to reduce the corrosion rates of the steel liner.

- Elevated temperatures will degrade the mechanical properties of Hanford SST concrete. However, supporting structural analyses have shown that predicted degradation has not significantly affected the load-carrying capacity of the tank structure.

- Because the primary factor determining the remaining useful life of the tanks is structural stability, the integrity examinations of the tanks should be continued.

F4.0 INTRODUCTION

The basic configuration of all of the SSTs is a reinforced-concrete tank structure lined with a carbon steel liner. In all of the SST designs, the steel liner provides the primary waste containment barrier and the reinforced concrete tank is designed to carry the internal and external loads. The steel liner is structurally independent from the reinforced-concrete tank. The waste compatibility with both the liner steel and tank concrete are discussed in this appendix.

The majority of the wastes stored in the SSTs are radioactive slurries generated by irradiated uranium fuel reprocessing using the bismuth-phosphate process, the reduction oxidation (REDOX) process, the plutonium-uranium extraction (PUREX) process, the tributyl phosphate (TBP) process, and the B Plant waste fractionation process. All of the fuel processing methods generated acidic waste streams. Sodium hydroxide or calcium carbonate was added to the waste before the waste was transferred to the tanks to neutralize the acid and thus minimize tank corrosion. The tanks currently contain moderately to strongly alkaline solutions, with the higher pH values exceeding 13. Additional post-processing of some of the wastes to recover plutonium and uranium, or to reduce the volume of high-level waste, has resulted in the addition of ferrocyanide and some organic compounds listed as hazardous (De Lorenzo et al. 1994). Hazardous characteristics of the waste are addressed in Appendix A.

The tanks now contain a mixture of salt cake, liquid, and sludges with both radioactive and hazardous components. Sludge consists primarily of solids (hydrous metal oxides) precipitated from the neutralization of acid wastes. Salt cake consists of the various salts formed from the evaporation of water from the waste. Liquids exist as supernatant (liquid above solids) and interstitial liquid (liquid filling the void between solids) in the tanks. These waste types do not necessarily exist as discrete layers, but are intermingled to different degrees. Some sludges and salt cake may contain interstitial liquids and be relatively soft, while others are drier and harder. The waste is mostly inorganic. It consists primarily of sodium salts of nitrate, sodium hydroxide; nitrite, carbonate, aluminate, and phosphate; and hydrous oxides of aluminum, iron, and manganese [De Lorenzo et al. (1994) and the Tank Waste Network Information System (TWINS) database (2002)].

By November 1980, all SSTs were removed from service, that is, they received no additional waste, and no additional transfers were made except for removing liquids. Consequently, as a result of the natural decay of the radioisotopes, the current tank temperatures are significantly below the maximum historical temperatures. As of February 28, 2002, 129 of the 149 SSTs had been interim stabilized (Hanlon 2002). This means that less than 50,000 gallons of drainable interstitial liquid and less than 5,000 gallons of supernatant liquid remain in each of the interim stabilized tanks.

It is well known that elevated temperature can degrade the mechanical and physical properties of reinforced concrete. Compressive and tensile strength, elastic modulus, and Poisson's ratio all decrease with elevated temperature. Elevated temperature will also increase the creep response of the concrete and can lead to a decrease in the bond strength between the concrete and the reinforcing steel. The threshold of significant degradation of concrete is approximately 150 to 200 °F. Current codes and industry standards for reinforced concrete structures specify maximum temperatures in this range to ensure predictable concrete behavior. For higher temperatures, potential degradation should be considered in structural evaluations.

Temperatures in portions of the concrete in some of the SSTs have exceeded design values during the operating history. The effect of elevated temperature on Hanford concrete is discussed in Section F7.3.

F5.0 SUMMARY

Tests performed on low carbon steel test coupons of the same type as the tank liner steel showed corrosion rates that varied from less than 1 mil per year (mpy) to 37 mpy, depending on the test conditions and the corrosion mechanism. Test times ranged from 5 days to 1 year. Pitting corrosion rates were typically higher than uniform corrosion rates for the same test, and corrosion rates generally increased with increasing temperature. Corrosion rates were typically highest in the vapor phase, less at the liquid-vapor interface, and least in the liquid or sludge, but there were exceptions to these trends. When corrosion rates were measured at different times during a test, the testing also showed that the corrosion rates often attenuated with time.

Because of the wide range of corrosion rates measured during different tests, and the uncertainty in in-service conditions, it is difficult to make quantitative predictions based on extrapolation of short-term test data to long-term in-tank conditions. However, it is important to recognize that the SSTs have stored waste significantly longer than the originally anticipated service life of the tanks, and corrosion is a time-dependent degradation mechanism. Thus, although in-tank conditions have become less aggressive, corrosion rates early in the operational period have evidently been high enough to perforate the liners of some tanks.

According to Hanlon (2002), 67 Hanford SSTs have been declared confirmed or assumed leakers, so it is obvious that the liners of at least some of the tanks have been breached by some mechanism. Results of SST integrity examinations reported in Appendix E show that some liners have significant visible corrosion, and that pitting corrosion at the liquid-vapor interface corresponding to prior liquid levels perforated the liners of some tanks. A few tanks have experienced bulges in the bottom of the liners. This is thought to result from expansion of steam underneath the liner. The stresses induced by the bulges, in combination with existing corrosion-induced liner degradation is another mechanism that may have resulted in breaches of the liners. On the other hand, photographs and videotapes of many SST liners show that the visible portion of the liners appears to be in very good condition. That is, there is very little visible evidence of significant corrosion. Given the more benign conditions that exist in the tanks today, it is likely that most of the degradation that will occur has occurred already. A recent corrosion estimate of SSTs for current low temperature conditions yielded a uniform corrosion rate value of 0.2 mpy (Anantatmula 1999).

Early corrosion testing of tank liner material based on the original waste stream compositions did not indicate that stress-corrosion cracking (SCC) was a significant degradation mechanism for the Hanford SSTs. However, the SST liners were not stress-relieved, and experience at the Savannah River Site (SRS) has shown SCC to be an important degradation mechanism in their tanks. Thus, even though there are design differences between the Hanford SSTs and SRS tanks that may reduce the propensity for SCC in the Hanford SSTs, it is not prudent to completely discount SCC as a significant corrosion mechanism in the Hanford tanks.

As discussed in Section F6.0 chemical attack is a significant degradation mechanism for Hanford concrete, and it is known that the Hanford SST waste contains chemical species that can adversely affect concrete. Results of tests that exposed Hanford concrete specimens to simulated waste solutions were dependent on test design, failure criteria, and the physical property being measured. A series of tests that immersed concrete specimens in chemical solutions reported unacceptable deterioration for some specimens based on volumetric expansion. A second series of tests using a different procedure that exposed only a portion of the surface of the specimens to chemical solutions concluded that neither the concrete nor the reinforcing steel showed evidence of adverse reactions. The test configurations for the immersion test and local exposure test were significantly different, and are probably best viewed as a worst-case and best-case scenario for the exposure of the concrete to tank waste. Thus, it is not surprising that the tests produced very different results.

Because some of the Hanford SSTs have leaked, portions of the concrete of some tanks have been exposed to tank waste. The stresses induced by the bulged liners, in combination with existing corrosion-induced liner degradation may have resulted in breaches of the liners, significant leaks, and exposure of the tank concrete to waste. The base, footings, and lower wall of the tanks are the most likely sites to have experienced significant exposure to tank waste. The degree of concrete degradation caused by such exposure is difficult to quantify because the lack of access to the bottom of the tanks precludes a visual inspection. However, as reported in Appendix E, remote visual examinations of the tank interiors do not show any obvious and extensive visible cracking in the dome concrete that might be associated with tank settlement caused by the concrete walls and footing being degraded by tank waste. Moreover, available dome elevation survey data have remained stable and within acceptable limits. That is, the available data support the conclusion that any structural degradation that may have occurred in the lower portion of the tanks has not significantly affected the overall structural stability of the tanks.

With the exception of the AX tank farm, the Hanford SST concrete was specified to have a 28-day compressive strength of 3,000 lbf/in^2. The AX tank concrete had a higher specified 28-day compressive strength of 4,000 lbf/in^2. Tests on Hanford concrete mixes having 28-day compressive strengths of 3,000 lbf/in^2 showed that the compressive strength of the concrete remained above the 28-day compressive strength even after 900 days at 450 °F. Similar tests on Hanford concrete mixes with a 28-day compressive strength showed a reduction in compressive strength of less than 10% below the minimum 28-day design strength after 920 days at 450 °F. After 900 days exposure to 350 °F, both batches had compressive strengths above the 28-day compressive strength. The above results are important because they show that even when Hanford concrete is exposed to significantly elevated temperatures for a considerable time, the compressive strength often remains above the original design value.

Of all the concrete properties examined, modulus of elasticity was the most sensitive to elevated temperature exposure. Results presented in Gillen (1980) show that the elastic modulus of Hanford concrete drops below the design value for specimens heated to 250 °F. The modulus of elasticity of concrete heated to 450 °F for 920 days was approximately 30% of the value measured for unheated concrete. The effect of reduced elastic modulus is to increase deflections and reduce the thermal stress. Poisson's ratio of heated concrete exhibited no well-defined relationships with respect to time or temperature.

As expected, the tendency of Hanford concrete to creep increases with increasing temperature. The effects of creep are to increase deflections and to redistribute stress from the concrete to the reinforcing steel. Thermal creep analyses of Hanford SSTs have been reported in Vollert (1973), Rashid (1976), Vollert (1979), and Julyk (1994). Although the analysis by Vollert (1973) did not consider the degradation of concrete strength or elastic modulus with temperature, all three analyses did predict that creep and cracking become stationary under typical operating conditions. That is, creep and cracking were predicted to be self-limiting.

A more recent and comprehensive structural integrity evaluation of the high-heat tank C-106 is documented in Julyk (1994). This analysis included a simulation of the thermal history and the material degradation properties of the tank, as well as the hydrostatic waste loads and lateral soil loads. The results indicate that there is very little difference between the predicted dome displacement at 45 and 55 years. These results imply that most of the creep deformation has already taken place. Thus, significant additional creep deformation is not expected for a constant load. In other words, this analysis also predicts that creep is self-limiting. The results of the tank C-106 analysis are applicable to all 530,000-gallon tanks because the design of the tanks is the same, and tank C-106 has the most severe thermal history of these tanks. Thus, all 100-series tanks in the B, C, T, U, and BX farms (a total of 60 tanks) are bounded by the tank C-106 analysis. The tank C-106 analysis is not as directly applicable to the other 100-series tanks because of differences in design details and soil overburden depths, and because the tank C-106 thermal history is not bounding for all other 100-series tanks. An analysis of a 1-million gallon tank based on the bounding thermal history of tank A-106 is discussed in Appendix G.

The stability of the dome elevation survey data discussed in Appendix E also supports the conclusion that no significant creep is currently occurring in the SSTs.

Tests conducted by the Portland Cement Association (PCA) have shown that the mean value for the coefficient of thermal expansion for Hanford concrete is $3.3 \times 10^{-6}/°F$. Testing performed in 1993 by the U. S. Bureau of Reclamation on concrete core samples from the Hanford T Plant resulted in an average value of $4.0 \times 10^{-6}/°F$ for the coefficient of thermal expansion (Winkel 1995). Both tests measured values that are significantly lower than the typical range of 4.5×10^{-6} to $7.0 \times 10^{-6}/°F$ for normal weight concrete and that are approximately half the value for steel.

The lower-than-typical value for the coefficient of thermal expansion for Hanford concrete has two significant effects. It will tend to reduce thermally induced stress in the concrete, but the mismatch in coefficients of thermal expansion between the concrete and the reinforcing steel creates the potential for degradation of the bond between the steel and the concrete during thermal cycling. The latter effect will have been most pronounced near the bottom of the tanks because of higher temperatures and higher temperature gradients. However, the results of the integrity examinations presented in Appendix E support the conclusion that any structural degradation that may have occurred in the lower portion of the tanks has not significantly affected the overall structural stability of the tanks.

F6.0 CORROSION TESTING ON CARBON STEEL LINER MATERIAL

The review of SST liner corrosion presented below is based on experimental programs conducted to determine the effects of corrosion of the liners by the mechanisms of uniform corrosion, pitting corrosion, and SCC. Sections F6.1 through F6.5 describe various experimental programs to determine the potential for liner corrosion based on the composition of the original waste streams.

The corrosion testing of the steel liners based on the original waste streams was conducted in the 1940s and 1950s. The corrosion experiments were designed to cover a range of test solutions that are expected to envelop the range of waste conditions that existed in the tanks during that period. These test parameters included pH, chemical composition, chemical concentration, temperature, and exposure of metal specimens to the liquid and vapor phase of the waste. Exposure of test specimens to the vapor phase is important because chemicals that inhibit corrosion in the liquid phase may not be present in the vapor phase.

During the 1960s and 1970s, the tank wastes generally became more concentrated, more intermixed, and some in-tank temperatures increased. Increasing waste temperature and concentration may have been conducive to corrosion, but there are no test data from this period to help quantify the effects of corrosion for in-tank conditions. On the other hand, as the wastes became more concentrated, the concentration of corrosion-inhibiting hydroxide and nitrite ions increased. Additionally, the concentration of the corrosion-inhibiting nitrite ion further increased as a result of radiolytic breakdown of nitrate compounds. The increase in hydroxide and nitrite and the decrease in the aggressive nitrate ion may have had an inhibiting effect on uniform corrosion, pitting corrosion, and SCC. The reduction in waste temperatures after the tanks were removed from service also tends to inhibit corrosion. However, there are no test data to quantify the degree of corrosion inhibition.

The following five sections present results of corrosion testing on low carbon steel test coupons. The tests were performed with either Society of Automotive Engineers (SAE) 1020 or SAE 1010 steel coupons substituted for the various carbon steel liner alloys (see Appendix A for types and properties of specific liner alloys). Both types of steel are similar to the tank liner steel and there is no significant difference in the corrosion resistance of SAE 1010, SAE 1020, and the liner steels.

F6.1 CORROSION TESTS IN BISMUTH-PHOSPHATE WASTE

Corrosion testing in synthetic and actual (in-tank) bismuth-phosphate ($BiPO_4$) wastes showed that in most cases, pitting corrosion rates and uniform corrosion rates were highest in the vapor phase, less at the vapor-liquid interface, and least in the liquid phase. Sanborn (1952) reported uniform corrosion rates in the vapor phase ranging from less than 1 mpy up to 7 mpy.
The higher rates occurred in solutions with a pH of less than 8. The results of the testing by Sanborn (1952) showed that uniform and pitting corrosion rates generally attenuated with time and increasing solution pH.

Endow (1954a) reported on the results of in-tank corrosion tests of SAE 1020 steel test coupons exposed to the waste in tanks TX-105, -109, and -117 for a period of seven months. Endow (1954a) reported uniform corrosion rates as high as 2.5 mpy and pitting corrosion rates as high as 18 mpy. Endow (1954a) showed that relatively high pitting corrosion rates existed in the vapor phase when ammonia vapors were not present. Laboratory experiments performed more recently with simulated wastes indicated that ammonia at a concentration of 100 ppm is a very effective inhibitor for uniform and pitting corrosion of carbon steel in the vapor phase (Anantatmula 1996). Endow (1954a) also makes reference to testing reported in Pitzer (1952), in which SAE 1010 steel test coupons were exposed to vapors over boiling simulated metal waste solution. The tests by Pitzer (1952) showed a maximum pitting corrosion rate of 37 mpy. Endow (1954a) recommended that additional testing be performed to correlate corrosion rates with time and temperature.

None of the test series in bismuth-phosphate waste showed a positive indication of SCC, but this may have been because the temperatures were not high enough or the test durations were not long enough.

F6.2 CORROSION TESTS IN TRIBUTYL PHOSPHATE WASTE

Only one reference (Groves 1954) was discovered that reported on corrosion rates of carbon steel in TBP solutions. The tests were conducted in synthetic TBP solutions based on ferrous ammonium sulfate and oxalate flow sheets. The tests were conducted to determine what effect, if any, the lowering of the pH at which the TBP waste is stored would have on the corrosion rate of the SAE 1020 carbon steel test coupons. The tests were conducted in solutions having pH values of 7, 8, and 9. SCC tests were not performed as part of this study.

The study tested for uniform corrosion and pitting corrosion rates with test durations of one and three months. The maximum reported uniform corrosion rates were 0.6 and 0.4 mpy for the one-month and three-month studies, respectively. The maximum reported pitting corrosion rates were 35 and 13 mpy for the one-month and three-month studies, respectively. The maximum average pitting corrosion rates for the one- and three-month studies were 15 and 10 mpy, respectively. There was no clear trend between the corrosion rates in the liquid and vapor phases. Comparison of the one-month and three-month pitting corrosion rates shows that rate of pitting corrosion decreased with increasing test times. Groves (1954) points out that the tests were of very limited duration for this type of study, and that extreme caution should be exercised if the data are extrapolated.

F6.3 CORROSION TESTS IN REDOX WASTE

REDOX corrosion investigations, while few in number, are salient because three of the four tests [Endow and Sanborn (1954), Mallett (1954), and Gruber (1957)] were conducted in actual waste tanks. The fourth test reported in Endow (1952) was conducted in synthetic REDOX waste solutions.

The purpose of the testing reported by Endow and Sanborn (1954) was to obtain corrosion data for SAE 1020 low carbon steel test coupons exposed to REDOX waste solution under actual operating conditions. Data were sought regarding the rates of uniform corrosion, pitting corrosion, and SCC of the steel exposed to the liquid-sludge phase of the waste at elevated temperatures resulting from self-concentration of the waste. In this test, no attempt was made to obtain data for steel exposed to vapors over the waste solution. Corrosion data were sought that would show the effect of the corrosion product build-up on the corrosion rate, and for this purpose the test was run for the relatively long time of nine months. At the time the specimens were introduced into tank S-104, the waste was boiling and the temperature of the sludge was known to have reached 250 °F and may have exceeded 300 °F. The test was designed to expose the specimens to the most severe conditions to which the tank liner was exposed.

The maximum pitting corrosion rate reported by Endow and Sanborn (1954) was 5 mpy and the maximum uniform corrosion rate was for three unstressed specimens (specimens not designed to test for SCC) was 0.6 mpy. No evidence of SCC was observed on the stressed specimen during the test.

Mallett (1954) reported the results of exposing four SAE 1020 carbon steel test coupons to actual REDOX tank waste for a period of nine months. Three of the specimens were unstressed and the fourth specimen was pre-stressed by bending it into a U-shape to test for SCC. Mallett reported pitting corrosion rates of 1 to 2 mpy with a maximum rate of approximately 4 mpy. No evidence of SCC was detected in the pre-stressed specimen. Temperatures to which the specimens were exposed are not stated in the report.

Gruber (1957) reported the results of ten SAE 1020 carbon steel test coupons exposed to in-tank REDOX waste in tank SX-107. The duration of the test was one year and the samples were exposed to both the liquid and vapor phases of the waste. One of the samples was welded and then pre-stressed to the yield strength of the material to test for SCC. The average pitting corrosion rate for the samples in the liquid and vapor phases were 1.9 and 2.8 mpy, respectively. The maximum pitting corrosion rates were 4.6 and 7.3 mpy, respectively. No evidence of SCC was observed on the stressed specimen. The temperatures to which the specimens were exposed were not stated in the report.

In tests reported by Endow (1952) SAE 1010 low carbon steel test coupons were used instead of SAE 1020 coupons. The steel coupons were exposed to synthetic REDOX waste at temperatures of 180, 200, and 220 °F in solutions with pH values of 11, 12, and 13. The test duration was 1,000 hours. The maximum reported uniform corrosion rate was 6 mpy for a specimen exposed to the vapor phase of a 200 °F solution with a pH value of 11. A lower corrosion rate of 2 mpy was observed in a specimen exposed to the vapor phase of a 220 °F solution at the same pH value. The report concluded that generally, corrosion is more severe in the vapor phase than at the liquid-vapor interface or in the liquid-sludge at the same temperature and that corrosion rates increased with increasing temperature for specimens exposed to the vapor phase. The data were considered to be too limited to establish a definite relationship between the corrosion rate and the pH value. The report also concluded that no severe pitting was observed and no accelerated attack was noted at the liquid-vapor interface. However, it was noted that the detection of pits in sandblasted specimens is difficult because pits are initially similar in appearance to the depressions in the metal resulting from sandblasting. The SST liners were cleaned by sandblasting prior to the application of protective coatings (see Appendix A).

F6.4 CORROSION TESTS IN PUREX WASTE

There were few investigations involving PUREX corrosion of liner steel. The earliest known testing was performed by Endow and reported in Ward (1953). Endow performed tests on SAE 1010 low carbon steel specimens exposed to PUREX process waste solutions at 220 °F. The test exposed polished and sandblasted specimens to the vapor phase and solution sludge, and the specimens were examined after one, two, and three months. The one- and two-month specimens showed uniform corrosion rates of less than 1 mpy and pitting corrosion rates of 12 mpy that were constant over a two-month period. Uniform corrosion rates for the three-month specimens were approximately the same as for the one-and two-month specimens indicating that the uniform corrosion rates had stabilized.

Endow (1954b) continued the work reported in Ward (1953) and reported average pitting corrosion rates of 24, 8, and 5 mpy for fine-sandblasted specimens that were exposed to the vapor phase of neutralized concentrated PUREX process waste for one, three, and ten months, respectively. The decrease in the pitting corrosion rates indicates that the rates decreased with increasing pit depth. Laboratory experiments performed more recently with simulated wastes indicated that pitting corrosion rates of carbon steel in the vapor phase decrease with time (Anantatmula 1996). Endow drew the following conclusions based on his tests:

- SAE 1010 steel exposed to vapors over neutralized PUREX waste solution is subject to severe initial pitting attack, but that the rate of attack decreases rapidly with time.
- There is no significant difference between a polished steel surface and a fine-sandblasted surface in their resistance to pitting attack in the vapor space.
- The uniform corrosion rates for steel exposed to the vapor, calculated on the basis that the attack is uniform over the surface, are approximately 1 mpy for these steel surfaces.
- The uniform corrosion rate for SAE 1010 steel exposed to the liquid-sludge is less than 1 mpy.
- No pitting was evident on the sandblasted surfaces and no cracks or other effects were noted.
- The possibility of the perforation of the waste storage tanks resulting from pitting attack is remote, however the data obtained from the laboratory tests cannot be used to predict accurately service life under operating conditions.

Note that based on the corrosion rates reported by Endow, his conclusion that there is a remote possibility of perforation of the steel liners likely results from his anticipation of a shorter service life than the tanks have actually experienced.

Parks (1957) also reports on in-tank testing done on unstressed, stressed, and welded SAE 1020 steel coupons subjected to PUREX waste solutions. Parks reports a maximum pitting corrosion in the vapor space of 2 mpy and a maximum pitting corrosion rate in the liquid of 10 mpy.

The unstressed samples had the lowest pitting corrosion rates in both the liquid and the vapor, and the pitting corrosion rates were significantly higher in the liquid than in the vapor phase. Only slight signs of intergranular corrosion were observed. The temperatures to which the specimens were exposed are not given in the report.

F6.5 SALT CAKE AND MOLTEN-SALT CORROSION TESTS

A periodic phenomenon observed in the waste tanks is the occurrence of localized hot spots at which elevated temperatures as high as 500 °F had been recorded as of 1958. It was postulated that the hot spots are the result of poor heat transfer in the salt cake on the bottom of the tank. On the assumption that the hot spots represent areas of partially molten salts, Walker (1958) performed tests to determine the corrosion effects of these hot spots on the SAE 1020 steel test coupons.

Four samples of SAE 1020 steel were placed in vials covered with a pulverized salt mixture corresponding to the composition of PUREX waste. The vials were then placed in a furnace at 500 °F. Two of the samples were unstressed and two of the samples were pre-stressed by bending them into a U-shape. The magnitude of the stress induced by bending the specimens was unknown. After 120 hours, one of the unstressed and one of the pre-stressed were removed from the furnace. The other two samples were removed after 625 hours. Signs of SCC were not observed and there was no preferential attack that might eventually lead to cracking. Walker (1958) concluded that while the investigation did not duplicate the conditions encountered in the tanks, it did indicate that hot spots do not pose a threat to the tank liners.

Payer et al. (1975) reported that uniform corrosion rate could be as high as 16 mpy in a salt cake composition. However, the majority of the tests showed rates that were less than 2 mpy. Molten-salt tests discussed in ASM 1987, pp. 51-52 and 88-91 showed no tendency for any uniform corrosion, pitting corrosion, or SCC.

F6.6 EXPERIENCES WITH STRESS CORROSION CRACKING AT THE SAVANNAH RIVER SITE

SCC refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. In the 1970s, a series of investigations was conducted at SRS to determine the cause of waste leakage from some of their tanks. Results of the investigations are reported in Poe (1974), Ondrejcin (1976), Donovan (1977a), Donovan (1977b), Ondrejcin (1978), and Ondrejcin et al. (1979). As a result of the investigations, nitrate-assisted SCC was directly confirmed at SRS as a failure mechanism for some of the early waste tanks that were not stress-relieved.

There are four basic designs of tanks at SRS that are referred to as Type I, Type II, Type III, and Type IV tanks. There are twelve Type I, four Type II, twenty-seven Type III, and eight Type IV tanks at SRS. Seven of the twelve Type I tanks and all four of the Type II tanks at SRS have exhibited leaks attributed to SCC. The Type I, II, and IV tanks were not stress-relieved. The Type III tanks have stress-relieved primary liners, and none of these tanks have had

SCC-induced leaks. There was also one Type IV tank storing low heat waste that failed by pitting corrosion.

The studies on the SRS tanks showed that SCC failures were associated with high residual stresses near welds, relatively high concentrations of nitrate, and low concentrations of nitrite. The peak temperatures in the SRS tanks that exhibited cracks caused by SCC were approximately 100 °C (212 °F). It is known that the propensity of SCC decreases with decreasing temperature.

The Hanford SST liners were not stress-relieved, and there are similarities in the composition of the contained waste. Thus, it is important to capitalize on the experiences at SRS and determine what lessons learned there might be applicable to the Hanford SSTs. However, although there are similarities in the design and operation of the Hanford SSTs and early SRS SST designs, there are also important differences.

In tanks that are not stress-relieved, the residual stress level near the welds will typically be near the yield strength of the material. The presence of the residual stress and the chemical composition of the waste are the two primary drivers for the initiation of SCC. However, unlike the SRS tank liners, the Hanford SST liners do not carry the hydrostatic loads induced by the tank waste. The absence of hydrostatic loads on the Hanford SST liners reduces one of the driving forces for the continued propagation of SCC. Another significant difference between the Hanford SSTs and the SRS tanks is that the SRS tanks generally have thicker liners. In the SRS tanks, the thickness for the majority of the vertical tank wall is 1/2 inch for Type I tanks and 5/8 inch for Type II tanks. The Type IV tanks have a wall thickness of 3/8 inch, but these tanks did not exhibit failures resulting from SCC. The liner thickness of the Hanford SSTs is 1/4 inch or 3/8 inch, depending on the design. The fact that the Type IV SRS tanks have not exhibited failure as the result of SCC suggests that the thinner Hanford SST liners are less susceptible to SCC than the thicker SRS liners, all other factors being equal.

F7.0 CHARACTERIZATION OF HANFORD CONCRETE MATERIAL PROPERTIES DURING IN-SERVICE CONDITIONS

Tank waste storage conditions can affect the structural integrity and mechanical properties of reinforced concrete. In this section, the most significant Hanford concrete degradation mechanisms are identified, and the results of tests that exposed Hanford concrete to simulated waste solutions and elevated temperatures are summarized.

F7.1 IDENTIFICATION AND RANKING OF HANFORD CONCRETE DEGRADATION MECHANISMS

Articles and reports that discuss degradation mechanisms for reinforced concrete structures include ACI 349.3R-95, Naus et al. (1996), Hookham (1995), Bandyopadhyay et al. (1997), Edgemon and Anantatmula (1996), and Jaske et al. (1994). The first three references focus on reinforced concrete of nuclear-related structures in general. The report by Bandyopadhyay et al. is directed toward the U.S. Department of Energy high-level waste storage tanks, and the last two references specifically identify the significant degradation mechanisms for reinforced concrete of the SSTs.

Although freezing and thawing, and leaching have been identified in Table F.1 as potentially significant in general, neither mechanism is expected to be significant in the SSTs. Freezing and thawing will not be a significant degradation mechanism because of the amount of backfill over the tanks, and leaching should not be significant because of lack of exposure to ground water at the Hanford Site. Thus, of the potentially significant concrete degradation mechanisms identified in Table F.1, the only three that are applicable to the SSTs are elevated temperature, aggressive chemical attack, and corrosion of embedded steel.

Table F.1. Potential Concrete Degradation Mechanisms for Nuclear Waste Storage Tanks (Bandyopadhyay et al. 1997)

Mechanism	Significance
Elevated Temperature	Potentially Significant
Freezing and Thawing	Potentially Significant
Leaching of Calcium Hydroxide or Other Soluble Constituents	Potentially Significant
Aggressive Chemical/Sulfate Attack	Potentially Significant
Corrosion of Embedded Steel	Potentially Significant
Alkali-Aggregate Reactions	Not Significant
Creep and Shrinkage	Not Significant
Abrasion and Cavitation	Not Significant
Irradiation	Not Significant

According to Jaske et al. (1994), pp. 4-46, the important damage mechanisms for Hanford concrete structures are:

1. Caustic chemical attack

2. Thermal exposure
3. External loading
4. Volume changes
5. Corrosion of reinforcing steel.

Jaske goes on to state that "Other material damage mechanisms are not likely to affect the life extension of waste tanks, transfer piping, and concrete structures at Hanford."

A similar ranking of Hanford concrete degradation mechanisms presented by Edgemon and Anantatmula (1996) is shown in Table F.2.

Table F.2. Ranking of Potential Concrete Degradation Mechanisms for Hanford Concrete Waste Tanks (Edgemon and Anantatmula (1996))

Ranking	Mechanism	Relative Probability of Occurrence (0-10)	Relative Probability of Causing Failure (0-10)	Risk Factor (0-100)
1	Elevated Temperature	7	3	21
2	Corrosion of Embedded Steel	3	5	15
3	Chemical Attack	2	7	14
4	Freeze/Thaw Cycles	2	6	12
5	Calcium Hydroxide Leaching	2	6	12
6	Aggregate/Alkali Reaction	2	5	10
6	Creep/Shrinkage	2	2	4
6	Radiation Effects	2	2	4

If the identification and ranking of the significant concrete degradation mechanisms are applied specifically to the Hanford SSTs, the most important degradation mechanisms are external loading, elevated temperature, corrosion of reinforcing steel, chemical attack, and volume changes resulting from creep and shrinkage.

In the case of the Hanford SSTs, the soil overburden load is carefully controlled and loading significantly beyond the authorization basis loads is highly improbable. Thus, if excessive uniform loading were to occur on a tank, it should not be expected to result from loads exceeding the authorization basis loads, but rather from reduced load-carrying capacity resulting from time-dependant degradation mechanisms. Structural analyses supporting the authorization basis loads are discussed in Appendix G. The effects of chemical attack and elevated temperature on Hanford concrete are discussed in Sections F7.2 and F7.3. The integrity examinations performed to monitor for any signs of degradation including those caused by rebar corrosion and volume changes are discussed in Appendix E.

Synergistic combinations of the above degradation mechanism can also occur, but are very difficult to predict. Fortunately, significant degradation of concrete usually results in cracking or spalling, although chemical attack will often manifest as surface erosion (exposed aggregate, loss of section) rather than as cracking or spalling. Therefore, although synergistic combinations of degradation mechanisms are difficult to predict, the degradation can be detected. There is still some risk that external loads and other degradation mechanisms can cause micro-cracking in concrete that is not immediately visible, but this is not necessarily structurally significant.

F7.2 THE EFFECT OF SIMULATED WASTE ON HANFORD CONCRETE

It is known that chemical species that can adversely affect reinforced concrete are present in Hanford SST waste. In all of the SST designs, the steel liner provides the primary waste containment barrier and the reinforced concrete tank is designed to carry the internal and external loads. However, when tank liners are breached and leak, the tank concrete is exposed to the waste. Table F.3 shows some of the chemicals that are contained in SST waste along with their effects on concrete [PCA (1989) and ACI 515.1R-79].

Table F.3. Effect of SST Waste-Borne Chemicals on Concrete

Chemical	Phase	Effect on Concrete
Sodium Hydroxide (NaOH)	Liquid	Disintegration if weight concentration of sodium hydroxide is greater than 20%
Sodium Nitrate ($NaNO_3$)	Liquid	Slow disintegration
Sodium Nitrite ($NaNO_2$)	Liquid	Slow disintegration
Sodium Phosphate ($NaPO_4$)	Liquid	Slow disintegration
Sodium Sulfate ($NaSO_4$)	Liquid	Disintegration in concrete with inadequate sulfate resistance
Ammonia	Vapor	Possible slow disintegration of moist concrete

The effect of high-temperatures and waste-borne chemicals on SST concrete was investigated in a series of small-scale tests conducted between 1976 and 1982. Two approaches were used to bound potential degradation scenarios. To simulate worst-case conditions, concrete samples were fully immersed in simulated waste solutions. Results of these tests are discussed in Section F7.2.1. To simulate the exposure of tank concrete to waste leaking through a small penetration in the liner, larger concrete test specimens were exposed to simulated waste solutions through slits in the bottom of a waste solution tank mounted on the test specimens. Results of the tests based on the second configuration are presented in Section F7.2.2. The two test configurations produced very different results.

F7.2.1 Experimental Results from Immersion Tests

In 1975, the Construction Technologies Laboratories Division of the PCA began a program to determine the durability of concrete exposed to aggressive solutions of the type encountered in the SSTs. Concrete mixes used in the testing program represented the concrete used in the Hanford waste tanks.

The testing reported by Stark (1976) involved 120 small concrete prisms measuring 3 by 3 by 11 ½ inches. One hundred and two of the prisms were plain concrete, while the other 18 contained a single No. 4 round deformed steel reinforcing bar 8 inches long and oriented axially in the concrete specimens. After a moist cure of 28 days, the specimens were immersed in chemical solutions for periods of 1, 2, 3, and 6 months, and stored at temperatures of 122, 212, and 302 °F. Nine chemical solutions (referred to as alkaline solutions) contained varying concentrations of $NaOH$, $NaNO_3$, and $NaNO_2$, as well as constant ratios of $NaAlO_2$, $NaCl$, $NaCO_3$, $(Na)_2SO_4$, NaF, and Na_3PO_4. The combination of alkaline solutions and temperatures provided a total of 27 exposure conditions. Three additional exposures included saturated $Ca(OH)_2$ solutions at 122, 212, and 302 °F.

After the specified exposure times, length, weight, and sonic measurements were made on the specimens. The report considered the length measurements to be the best indicator of concrete "durability." Stark describes the failure criterion for length measurements as the "usual failure criterion of 0.10% expansion." Although Stark does not elaborate on the origin of the "failure criterion," expansion of 0.10% is a typical threshold for determining the presence of an undesirable chemical reaction between highly alkali cements and certain types of reactive aggregates (Troxell and Davis 1956). The determination of such reactions is discussed further in ASTM Standards C 586-99 *Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)* and C 1105 *Test Method for Length Change of Concrete Due to Alkali-Carbonate Reaction*. ASTM Standard C 586-99 includes the following interpretation of test results regarding the expansion of aggregates:

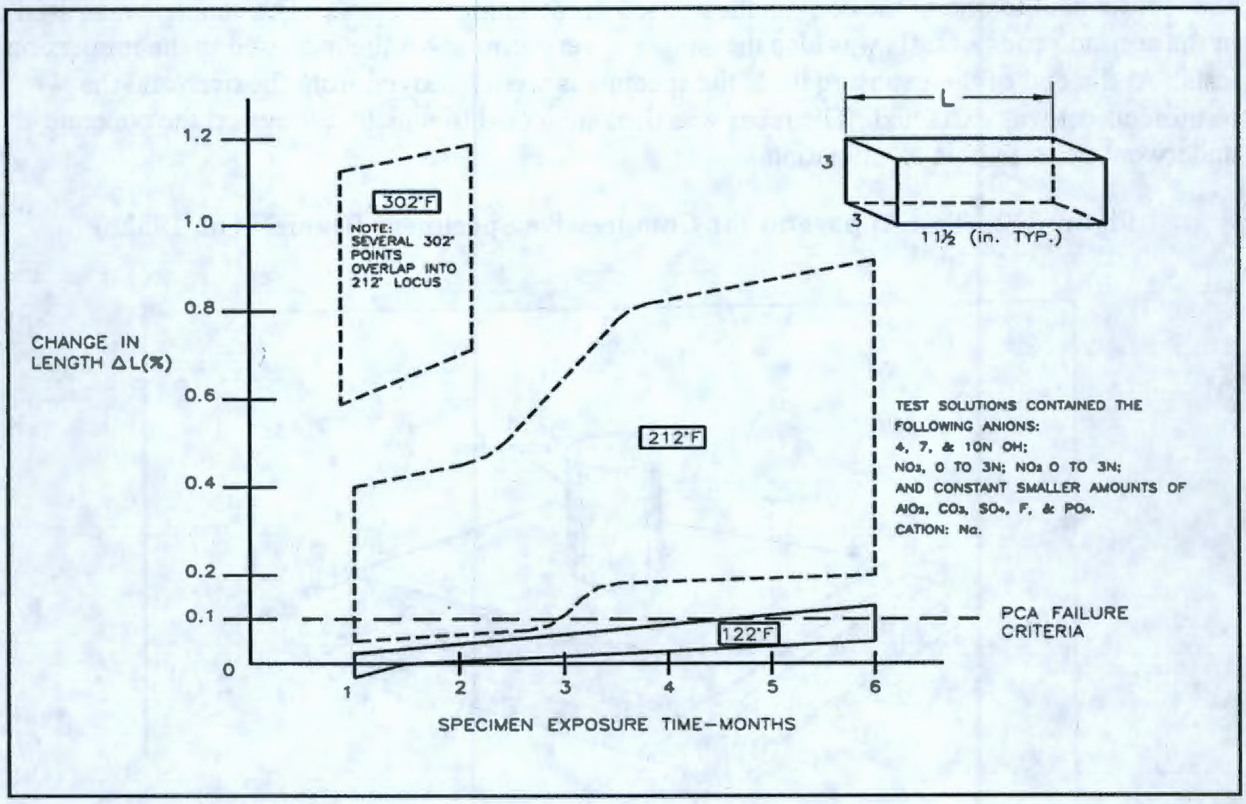
> Research results have indicated that the expansive behavior of aggregate in concrete is qualitatively predicted by the results of the rock cylinder test. Quantitative prediction of the expansion of concrete containing reactive aggregate depends upon (1) the degree of aggregate reactivity, (2) the amount of reactive constituent, (3) the alkali content of the cement, and (4) the environment. Appreciable expansion should indicate the need for further testing. In the light of current knowledge, it appears that expansions in excess of 0.10% are indicative of chemical reaction and should warrant additional testing preferably in concrete using Test Method C 1105.

The above paragraph describes the expansion of rock aggregate immersed in a solution of sodium hydroxide at room temperature.

The tests performed by Stark (1976) showed that essentially all deterioration began on the peripheral areas of the test specimens and progressed inward. The effect of the deterioration on the structural behavior of the tank concrete will depend on the extent of the concrete degradation in the in situ condition. Because the test specimens were immersed in the chemical solutions, it is reasonable to interpret the test results as a worst-case scenario for chemical attack on the in-service SST concrete.

Test results shown in Figure F.1 indicate that all specimens stored in alkali solution at 302 °F exceeded the failure criterion in one month (Stark 1976). At 212 °F, all specimens stored in alkali solution exceeded the failure criterion in three months. At 122 °F, some of the specimens exceeded the failure criterion in six months, depending on the chemical concentrations in the solution. The specimens that experienced greater expansion also showed deterioration in the form of surface cracks, and some specimens also experienced small spalls or popouts. After six months, the specimens with the reinforcing steel were broken open and the embedded steel was examined. There was no evidence of corrosion of the reinforcing steel, though the author points out that this is probably because essentially all deterioration developed along the peripheral areas of the test specimens, and tests were discontinued prior to the penetration of the test solutions to the steel.

Figure F.1. Effect of Simulated SST Liquid Waste Exposure on the Change in Length (ΔL) of Concrete Specimens, Fully Immersed at 122, 212, and 302 °F (Stark 1976)



The report concludes that highly alkaline storage solutions aggressively attacked the test specimens, as indicated by the excessive expansions recorded in less than a six-month period. For the alkaline solutions, increased temperature was more detrimental than solution composition. None of the specimens stored in calcium hydroxide solutions at elevated temperature showed evidence of cracking or excessive expansion. This is evidence that temperature alone did not induce deterioration of the concrete.

F7.2.2 Experimental Results Based on Local Exposure to Simulated Waste Solutions

The testing reported in Kaar and Stark (1979), Kaar and Stark (1981), Daniel et al. (1982a), and Daniel et al. (1982b) was based on a significantly different experimental configuration than the earlier immersion tests reported by Stark (1976). In the second series of tests, specimens were exposed to simulated waste solutions through slits in the bottom of a waste solution tank mounted on the test specimens as shown in Figure F.2 and Figure F.3. All concrete specimens were 36 inches long, 9 inches deep, and 12 inches wide and were reinforced with three No. 4

steel reinforcing bars with a top and side cover of 3 inches. The specimens were maintained under either sustained flexure or sustained compression. The compression specimens were uncracked, and held at 500 lbf/in^2 compressive stress. The flexure specimens were cracked and loaded so that the rebar stress in some specimens was 10 kip/in^2, while in the other specimens the rebar stress was 20 kip/in^2. All specimens were held at 180 °F in an oven and exposed to simulated waste solution. The simulated waste solution used in the second series of tests was almost identical to one of the combinations used in the immersion tests. The concrete mix used in the second series of tests was also the same (or very similar to) the mix used in the immersion tests. At the end of the exposure time, the specimens were removed from the oven and the reinforcement was extracted. The rebar was then subjected to tensile testing and the concrete underwent petrographic examination.

Figure F.2. Test Apparatus for Compressive Specimens (Daniel et al. 1982b)

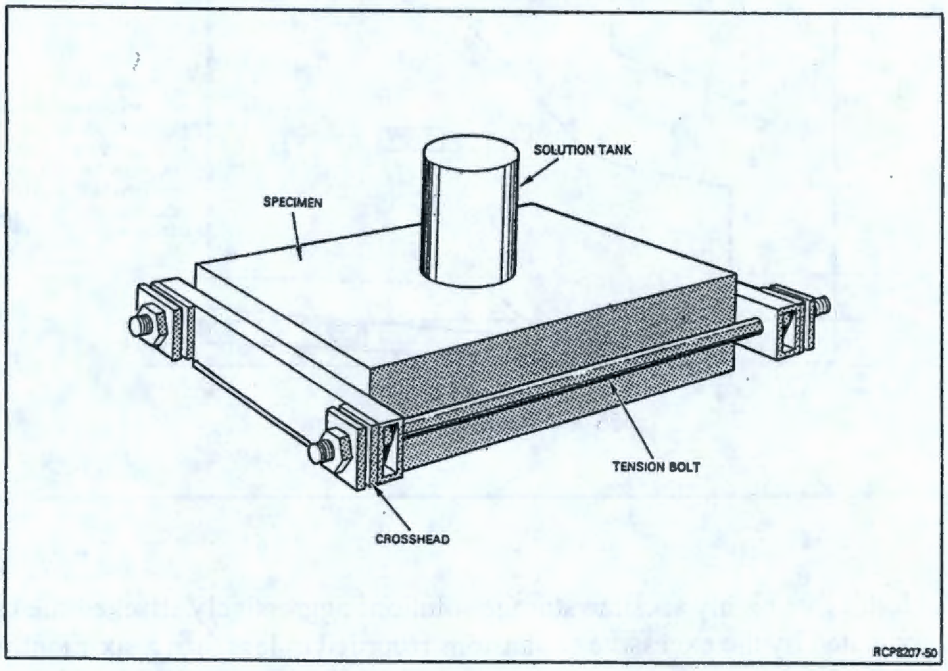
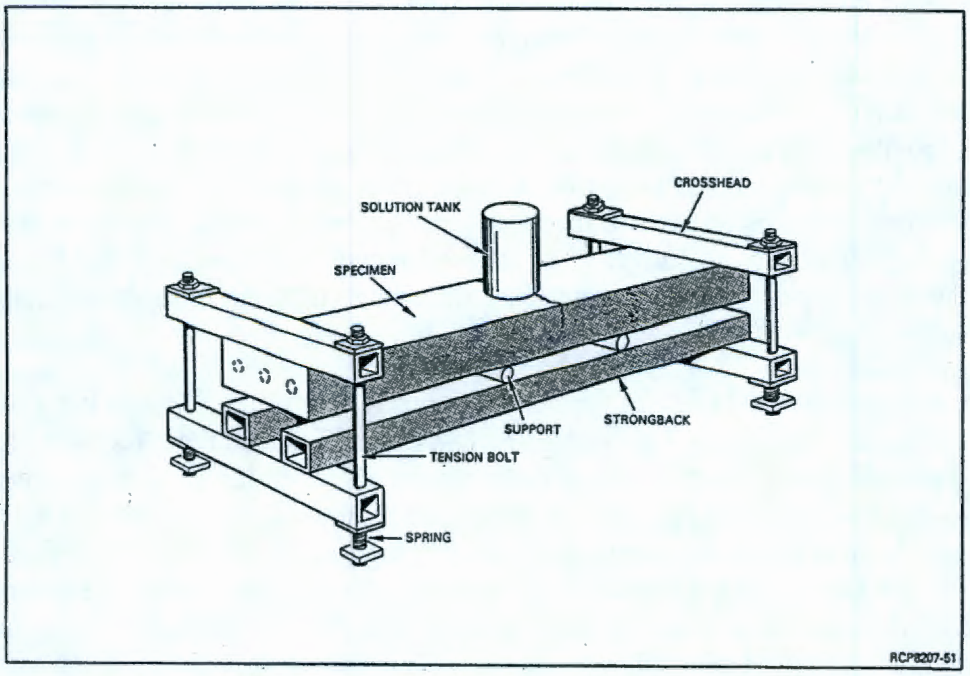


Figure F.3. Test Apparatus for Flexural Specimens (Daniel et al. 1982b)



Kaar and Stark (1979) and Kaar and Stark (1981) report on the test results after six and nineteen months of exposure, respectively. In both reports, the authors conclude that there was no evidence of rusting, cracking, or disruption of the mill scale initially on the steel. Physical testing of the reinforcement showed no effects from the exposure agents. Petrographic examination of the concrete showed no evidence of adverse reactions between the solution and the concrete.

The tests reported in Daniel et al. (1982a) were essentially the same as those reported by Kaar and Stark (1979), and Kaar and Stark (1981), except that the concrete specimens were exposed to simulated waste for 13 months, followed by a 12-month exposure to a simulated double-shell tank slurry. The simulated double-shell tank slurry was similar to the simulated waste solutions, but had higher concentrations of $NaOH$, $NaNO_3$, $NaNO_2$, and $NaAlO_2$. The conclusions in Daniel et al. (1982a) were the same as reported by Kaar and Stark in 1979 and 1981. That is, neither the reinforcing steel nor the concrete showed evidence of adverse reactions. Daniel et al. (1982b) reported the same results for specimens exposed to the waste for 36 months.

F7.3 THE EFFECT OF ELEVATED TEMPERATURE ON HANFORD CONCRETE

The applied loads and the ability of the tank materials to carry these loads influence tank structural integrity. To assess the tank structural integrity, the condition of the structural materials must be established. The original design criteria and subsequent effects of aging and elevated temperature on material properties must be evaluated. This section presents a review of documentation establishing elevated temperature effects on Hanford concrete.

Aging effects, in part, consist of material degradation mechanisms resulting from exposure to temperature over time. Over a long period of time this degradation of SST concrete could be significant and the structural integrity and useful life could be compromised. Therefore, time is an important factor in the material degradation process. However, without the degrading effects from elevated temperature exposure or chemical attack, the strength of concrete usually increases with age. This strength increase generally enhances the structural load-carrying capability beyond the capacities associated with the 28-day design compressive strength. In practice, the added strength of the concrete resulting from aging beyond 28-days strength is rarely considered. Normally, concrete is not tested beyond the 28-day age of the concrete. For the structural evaluation of the SST structures, longer-term concrete test data are available and the increased strength of the concrete resulting from aging has often been included in the more recent structural evaluations.

In general, the exposure of concrete to temperatures much greater than 150 °F has a degrading effect on the physical properties of the concrete. Davis (1967) states that "Exposure to temperatures greater than 70 or 80 °F has a deteriorating effect on the physical properties of Portland cement concrete. However, for constant temperatures up to 150 or 200 °F, the loss in strength, if any, is quite small; and for temperatures as high as 500 to 600 °F, the deterioration in structural properties is ordinarily tolerable." The primary structural issue is strength reduction, but elevated temperatures also affect other properties, including the modulus of elasticity, Poisson's ratio, and creep rate.

Evaluation and testing of Hanford concrete began in the 1970s and continued into the 1980s. One of the key issues addressed by the testing was the determination of the effects of elevated temperature on the mechanical properties of Hanford concrete. Test data were obtained from the tests of concrete specimens fabricated in the PCA laboratories using aggregates from the same source used in the construction of the SSTs. Core samples taken from the dome and walls of typical tanks were also tested.

F7.3.1 Review of Significant Reports on the Mechanical Properties of Hanford Concrete at Elevated Temperature

Fourteen of the most significant reports on the mechanical properties of concrete are summarized below. The first 11 reports provide test results specific to Hanford concrete. The report by Kassir et al. (1996) is not specific to Hanford concrete, but it provides a good discussion of the properties of concrete at elevated temperatures based on a broad database. The reports by Henager et al. (1988) and Peterson (1994) provide compilations and correlations of test data that support the current approach to the structural modeling of Hanford concrete.

1. Gillen, M., 1982a, *Durability and Estimated Lifetime of Hanford Concrete*, RHO-RE-CR-6

   This report describes the influences of prolonged exposure to elevated temperatures on the durability of Hanford concrete mixes. A regression analysis of strength and modulus of elasticity test data are developed for Hanford-mix concrete exposed to a 350 °F temperature environment for up to 3.5 years. The maximum strength reduction observed was in the range of from 20 to 25 percent. Similar reductions were noted for modulus of elasticity. The compressive strength of concrete cores taken from A tank farms, after 20 years of service when tested at 250 °F, was well above the initial minimum specified 28-day strength.

2. Gillen, M., 1978a, *Expansion of Hanford Concrete*, RHO-C-21

This report presents results of measurements of thermal expansion of concrete cores from Hanford facilities and concrete cast at Construction Technology Laboratories made with materials and mix designs similar to Hanford concrete. Cores were taken from the PUREX Plant and from the tank farms.

All cylinders had been conditioned in a fog room maintained at 100% relative humidity and 73 °F before preparation. Cores were then stored at 50% relative humidity and 73 °F until tested.

The thermal expansion data for the PUREX samples agreed with the Construction Technology Laboratories comparison sample below 400 °F. Above that temperature, the PUREX thermal expansion was higher.

The thermal expansion for the waste tank samples was lower than either the PUREX or Construction Technology Laboratories samples.

3. Gillen, M., 1978b, *Strength and Elastic Properties of Concretes From Waste Tank Farms*, RHO-C-22

A series of tests was performed on concrete that was maintained at elevated temperatures for various lengths of time. The concrete tested was taken from existing tank farm structures as follows:

- Series A, from 241-A
- Series T, from 241-T
- Series U, from 241-U
- Series K, from Lab
- Series M, from ongoing research.

Internal voids and cracks were discovered during compressive strength tests in several tank farm 3-inch by 6-inch cylinders. These voids and cracks will have more influence on the smaller samples. It is believed that there was a large variation in the strength of the concrete that was used throughout the construction of the tank farm structures. There is not enough consistency in the results to draw a definitive conclusion about strength degradation at elevated temperatures for the Hanford core specimens, however the data are included in later correlations. In general, it is shown that concrete properties degrade during prolonged exposure to elevated temperatures.

4. Gillen, M., 1979a, *Creep and Cycling Tests - Thermal Properties of Hanford Concrete*, RHO-C-27

The objective of the test reported here is to determine the thermal properties of Hanford concrete. The specific heat, thermal conductivity and thermal diffusivity were measured as functions of temperatures ranging from 79 to 1175 °F. Two test specimens were obtained from concrete cored from the 202-A PUREX Canyon Building. Two additional tests with Construction Technology Laboratories concrete made with materials and mix designs similar to Hanford concrete.

All test specimens were dried at 221 °F to constant weight before testing. The tests determined that Hanford thermal properties of specific heat, thermal conductivity, and thermal diffusivity are at the lower limit of the range of values given in engineering data tables for concrete weighing 140 lbf/ft^3. These results are attributed to the basalt in the aggregate.

5. Abrams, M. S., et al., 1979, *Elastic and Strength Properties of Hanford Concrete Mixes at Room and Elevated Temperatures*, RHO-C-28

Tests were conducted on two Hanford concrete mixes to determine the modulus of elasticity, Poisson's ratio, compressive strength, and splitting tensile strength at room temperature and elevated temperatures.

Materials for the mixes and mix design information were furnished by Hanford. Raw materials were from the same source as that used for tank construction. The nominal strength of the concrete mixes was 3,000 and 4,500 lbf/in^2.

For both concrete mixes, the modulus of elasticity dropped sharply during the first 30 days of heating. From that point on, the drop of modulus was much more gradual and the effects of temperature on the concrete with regard to the modulus of elasticity were very pronounced. The lowest values were obtained at 450 °F. Compressive strength data for the concrete heated 250, 350, and 450 °F for over 900 days were very erratic. However, for most cases, strength decreased with increasing temperature and length of exposure.

6. Gillen, M., 1979b, *Cyclic Thermal Expansion Testing of Hanford Concrete*, RHO-C-35

Changes in the thermal expansion characteristics of Hanford concrete caused by repeated exposure to elevated temperatures were studied in this report. Eight dilatometer specimens were tested at temperatures ranging from ambient to 450 °F. Five temperature cycles from ambient to 450 °F at a rate of 10 °F/min were completed during one working day. Most noted here is the dehydration that occurs in the first cycle. This report ignores subsequent re-hydration. After the first cycle, the results are consistent with an average coefficient of thermal expansion of 3.9×10^{-6}/°F.

7. Gillen, M., 1979c, *Strength and Elastic Properties of 1580-day Hanford Concrete Cylinders at Room Temperature and 350 °F*, RHO-C-40

   This report describes strength and elastic property tests that were conducted on 11 concrete specimens at room temperature and 350 °F. Specimens were made from materials and mix designs similar to those used in Hanford facilities. Results compared favorably with data obtained from similar concrete cylinders tested at earlier ages. No significant changes from previously reported results were observed.

8. Daniel, J. L., and A. O. Buck, 1980, *A Comparison of the Microstructure of Hanford Concrete Structure and Test Specimens*, RHO-C-39

   This investigation was designed to identify the microstructural effects of stressing, temperature, surface chemical application, and aging on Hanford Type II concrete. The prime conclusion was that there were no outstanding differences or changes at the microstructure level resulting from the various environmental factors. Changes that may have occurred are masked by the normal variations in concrete microstructure. It was noted the 35-year-old Hanford samples showed no signs of degradation at a microstructure level. Some samples were taken from the Series K specimens used in Gillen (1978b).

9. Gillen, M., 1980, *Final Report on Long-Term Creep of Hanford Concrete at 250 °F and 350 °F*, RHO-C-50

   This report describes results on a study of creep behavior of Hanford concrete at 250 °F and 350 °F. Results of elevated temperature tests covering a period of 21 months are reported. Test specimens were six 6-inch by 12-inch cylinders with materials and mix design similar to those used in Hanford concrete facilities.

   It was found that the creep doubled from 250 to 350 °F for the same load. The creep also doubled when the load went from 500 to 1,500 lbf/in^2 for the same temperature. A non-linear expression is developed with time as the only variable for the three different sets of test data.

10. Gillen, M., 1981, Effects *of Moisture Loss due to Radiolysis on Concrete Strength*, RHO-RE-CR-4

    This report presents results of a literature search of data on effects of moisture loss resulting from radiolysis on concrete strength. It is concluded that the primary mechanism for drying of irradiated concrete is caused by heat released within the concrete from energy supplied by absorbed radiation, and not by direct action of radiation on water molecules. It appears that based on available evidence, it can be assumed that drying of concrete by radiolysis and drying by heating are equivalent phenomena.

11. Gillen, M. P., 1982b, *Strength and Elastic Properties Tests of Hanford Concrete Cores – 241-SX-115 Tank and 202-A PUREX Canyon Building*, RHO-RE-CR-2

Specimens fabricated from concrete cores obtained from tank SX-115 and the 202-A PUREX Canyon Building were tested to determine compressive strength, splitting tensile strength, modulus of elasticity and Poisson's ratio. Eighteen tank farm specimens and 17 PUREX specimens were tested after exposure to elevated temperatures.

No signs of chemical attack were visible during inspection of SX-115 cores The tank farm core from SX-115 was continuous and comparisons along the length of the core were made. There appears to be a reduction in strength down the length of the core sample toward the bottom. The variation between adjacent specimens is greater than this apparent strength reduction. The average values obtained from the tank farm specimens were: compressive strength = 5550 lbf/in^2; splitting tensile strength = 765 lbf/in^2; modulus of elasticity = 4.98 million lbf/in^2, and Poisson's ratio = 0.21.

The PUREX specimens were tested under three temperature conditions: unheated, heated to 200 °F, and heated to 200 °F and then cooled to ambient. Average values for unheated concrete were: compressive strength = 4810 lbf/in^2; splitting tensile strength = 428 lbf/in^2; modulus of elasticity = 3.53 million lbf/in^2, and Poisson's ratio = 0.18. For specimens heated to 200 °F, average values were: compressive strength = 4,040 lbf/in^2; modulus of elasticity = 2.37 million lbf/in^2, and Poisson's ratio = 0.14. For PUREX Plant specimens heated to 200 °F and subsequently tested at 72 °F, average values were: compressive strength = 4,720 lbf/in^2, modulus of elasticity = 2.83 million lbf/in^2, and Poisson's ratio = 0.18.

A visual examination was made of all core materials as received. Six specimens were found to have visible cracks varying from 2 to 10 inches long. Several pieces of large aggregate in two core samples were found to have cracks. No other sign of deterioration of cement matrix or aggregates was visible.

12. Kassir, M. K., et al., 1996, *Thermal Degradation of Concrete in the Temperature Range from Ambient to 315°C (600°F)*, BNL-52384

This document presents the results of an independent literature review of the effects of elevated temperature on the properties of concrete. The compressive strength and modulus of elasticity tend to decrease over a large range with increasing temperature. Because of differences in the coefficients of expansion between concrete and the reinforcement steel, the bond strength between concrete and the reinforcement steel tends to decrease with increasing temperature. Thermal cycling causes progressive degradation of concrete with increasing number of cycles though most of the damage occurs in the first few cycles.

13. Henager, C. H., et al., 1988, *Modeling of Time-Variant Concrete Properties at Elevated Temperatures*, PNL-7779

    This report presents the analysis of the complete PCA database of the Hanford-mix concrete test data including exposures to elevated temperatures of 250, 350, and 450 °F for up to 1,300 days (3.5 years). The PCA database included laboratory test results for modulus of elasticity, compressive strength, splitting tensile strength, and Poisson's ratio of 3,000 and 4,500 lbf/in^2 Hanford-mix concrete. Limited creep strain data for 4,500 lbf/in^2 Hanford-mix concrete at 250 and 350 °F for up to 650 days was also available. Since the concrete property equations used in previous applications of the SAFE-CRACK® computer program in structural evaluations of the Hanford underground waste storage tanks were developed before completion of the PCA study, the SAFE-CRACK® property equations were re-evaluated based on the full PCA database. Although there were differences between the previous SAFE-CRACK® property equations and the results obtained from the analysis of the full PCA database, they were in reasonable agreement. The use of a wider database in the development of the SAFE-CRACK® creep equations was justified because of the limited nature of the PCA creep data. See Peterson (1994) for a recent re-assessment of the Hanford-mix concrete strength and modulus test data.

14. Peterson, W. S., 1994, *Evaluation of Strength and Modulus Degradation Due to Temperature Effects on Hanford Concrete*, WHC-SD-WM-DA-153, Rev. 0

    This report documents a recent re-assessment of the Hanford-mix concrete test data [Abrams et al. (1979) and Henager et al. (1988)] relating concrete degradation with time at elevated temperature. The results from the re-assessment are more in line with the long-term lower bound residual strength and modulus relations given in Kassir et al. (1996) which were based on a broader database. The re-assessed degradation in compressive strength with time at temperature was consistent with the results in Henager et al. (1988), however the degradation in elastic modulus was not. The report by Henager et al. (1988) predicts a lower elastic modulus (about 50% lower) at long times than was predicted by the re-assessment. Hence, the application of the correlation given in Henager et al. (1988) would lead to an under-prediction of thermal stress and an over-prediction of deflections.

F8.0 REFERENCES

ACI 1993, *Corrosion of Metals in Concrete*, American Concrete Institute, ACI 222R-89, American Concrete Institute Manual of Concrete Practice, Part 1, Detroit, Michigan.

ACI 1994, *ACI Manual of Concrete Practice Part 1 – 1994*, American Concrete Institute, Detroit, Michigan.

ACI 349.3R-95, *Evaluation of Existing Nuclear Safety-Related Structures*, ACI Manual of Concrete Practice, American Concrete Institute, Detroit, Michigan.

ACI 515.1R-79, *A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete*, American Concrete Institute, Detroit, Michigan.

Abrams, M. S., M. Gillen, and D. H. Campbell, 1979, *Elastic and Strength Properties of Hanford Concrete Mixes at Room and Elevated Temperatures*, RHO-C-28, Rockwell Hanford Operations, Richland, Washington.

Agnew, S. F., 1997, *Hanford Tank Chemical & Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos New Mexico.

Allen, G. K., 1975, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 Through 1975*, ARH-CD-610B, Atlantic Richfield Hanford Co., Richland, Washington.

Anantatmula, R. P., 1999, *Recommendation of Uniform Corrosion Rates for Double-Shell Tanks and Single-Shell Tanks*, Letter to K. M. Hodgson, dated January 29, 74700-RPA-006, Lockheed Martin Hanford Corporation, Richland, Washington.

Anantatmula, R. P., 1996, *DST Pitting Annual Report*, WHC-SD-WM-PRS-016, Rev. 0, Westinghouse Hanford Co., Richland, Washington.

Anantatmula, R. P., M. J. Danielson, and E. B. Schwenk, 1994, *Characterization of the Corrosion behavior of the Carbon-Steel Liners in Hanford Site Single-Shell Tanks*, WHC-EP-0772, Westinghouse Hanford Co., Richland, Washington.

ASM 1987, Metals Handbook Ninth Edition, Volume 13, Corrosion, ASM International, Metals Park, Ohio.

Bandyopadhyay, K., et al, 1997, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, BNL-52527, Brookhaven National Laboratory, Upton, New York.

Bendixsen, R. B., 1990, *Sludge in Aging Waste Tank and Maximum Observed Temperature*, WHC-SD-WM-TA-019, Westinghouse Hanford Co., Richland, Washington.

Boomer, K. D., et al 1993, *Tank Waste Technical Options Report, Appendix D, Tank Waste Radionuclide and Chemical Compositions*, WHC-EP-0616, Rev. 0, Westinghouse Hanford Co., Richland, Washington.

Connor, L. P., Editor, 1987, Welding Handbook, 8th Edition, Welding Technology, Chapter 7, Residual Stresses and Distortion, American Welding Society, Miami Florida.

Cook, M. W., and J. M. Gerhart, *Waste Tank Temperature Studies*, HW-47087, General Electric Co., Richland, Washington.

Costas, L. P., M. L. Holzworth, and W. C. Rion, 1966, *Stress Corrosion Cracking of Carbon Steel in Simulated Waste Solutions*, DP-1023, DuPont, Savannah River Laboratory, Aiken, South Carolina.

Daniel, J. L., and A. O. Buck, 1980, *A Comparison of the Microstructure of Hanford Concrete Structure and Test Specimens*, RHO-C-39, Rockwell Hanford Operations, Richland, Washington.

Daniel, J. I., D. C. Stark, and P. H. Kaar, 1982a, *Effects of Double-Shell Slurry on the Corrosion of Reinforcing Steel*, Progress Report No. 4 to Rockwell Hanford Operations, Submitted by Construction Technology Laboratories, A Division of the Portland Cement Association, Skokie, Illinois.

Daniel, J. I., D. C. Stark, and P. H. Kaar, 1982b, *Long-Term Effects of Waste Solutions on Concrete and Reinforcing Steel*, RHO-RE-CR-8 P, Construction Technology Laboratories, A Division of the Portland Cement Association, Skokie, Illinois.

Davis, H. S., 1967, "Effects of High-Temperature Exposure on Concrete," *Materials Research and Standards*, Vol. 7, No. 10, 1967, pp. 452-459.

De Lorenzo, et al., 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Prepared for Westinghouse Hanford Company by Los Alamos Technical Associates, Kennewick, Washington.

Donovan, J. A., 1977a, *Materials Aspects of SRP Waste Storage – Corrosion and Mechanical Failure*, DP-1476, E. I. DuPont De Nemours and Company, Savannah River Laboratory, Aiken, South Carolina.

Donovan, J. A., 1977b, "Factors Controlling Nitrate-Cracking of Mild Steel," *Corrosion 77*, San Francisco, California, pp. 8.1-8.9.

DPST 1973, *Savannah River Laboratory Quarterly Report, Waste Management*, DPST-73-125-1, January-March 1973, E. I. DuPont de Nemours & Co., Savannah River Laboratory, Aiken, South Carolina.

Endow, N., 1952, *Corrosion Tests – SAE 1010 Mild Steel in Synthetic Neutralized REDOX Waste Solutions*, HW-26201.

Endow, N., 1954a, *Field Corrosion Tests – SAE 1020 Steel in Bismuth Phosphate Process Waste Solution Tanks*, HW-30641, General Electric Co., Richland, Washington.

Endow, N., 1954b, *A Laboratory Study of the Extent of Pitting and General Corrosion of SAE-* Electric Co., Richland, Washington.

Edgemon, G. L., and R. P. Anantatmula, 1996, *Hanford Tank Waste System Degradation Mechanisms*, WHC-SD-WM-ER-414, Rev. 0a, Lockheed Martin Hanford Company, Richland, Washington.

Gillen, M., 1978a, *Expansion of Hanford Concrete*, RHO-C-21, Construction Technology Laboratories, a Division of the Portland Cement Association, Skokie, Illinois for Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1978b, *Strength and Elastic Properties of Concretes from Waste Tank Farms*, RHO-C-22, Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1979a, *Creep and Cycling Tests - Thermal Properties of Hanford Concrete*, RHO-C-27, Construction Technology Laboratories, a Division of the Portland Cement Association, Skokie, Illinois for Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1979b, *Cyclic Thermal Expansion Testing of Hanford Concrete*, RHO-C-35, Construction Technology Laboratories, a Division of the Portland Cement Association, Skokie, Illinois for Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1979c, *Strength and Elastic Properties of 1580-day Hanford Concrete Cylinders at Room Temperature and 350 F*, RHO-C-40, Construction Technology Laboratories, a Division of the Portland Cement Association, Skokie, Illinois for Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1980, *Final Report on Long-Term Creep of Hanford Concrete at 250 and 350 F*, RHO-C-50, Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1981, *Effects of Moisture Loss due to Radiolysis on Concrete Strength*, RHO-RE-CR-4, prepared by, Construction Technology Laboratories, a Division of the Portland Cement Association, Skokie, Illinois for Rockwell Hanford Operations, Richland, Washington.

Gillen, M., 1982a, *Durability and Estimated Lifetime of Hanford Concrete*, RHO-RE-CR-6, Rockwell Hanford Operations, Richland, Washington.

Gillen, M. P., 1982b, *Strength and Elastic Properties Tests of Hanford Concrete Cores – 241-SX-115 Tank and 202-A PUREX Canyon Building*, RHO-RE-CR-2, Rockwell Hanford Operations, Richland, Washington.

Girdler, R. M., 1965, *Leaks in Radioactive-Waste Tanks*, DP-990, E. I. Du Pont de Nemours & Company, Savannah River Laboratory, Aiken South Carolina.

Godfrey, W. L. and W. C. Schmidt, 1969, *Boiling Waste Tank Farm Operational History*, RHO-R-39, Rockwell Hanford Operations, Richland, Washington.

Graver, D. L. 1985, Corrosion Data Survey Metals Section, 6th Edition, National Association of Corrosion Engineers (NACE), Houston Texas.

Groves, N. D., 1953, *Corrosion Effects of Lowering the pH of the TBP Waste Stream*, HW-29183, General Electric Co., Richland, Washington.

Groves, N. D., 1954, *Corrosion Effects of Lowering the pH in TBP Waste Storage Tanks*, HW-30041, General Electric Co., Richland, Washington.

Gruber, W. J., 1957, *Interim Report on the Examination of Corrosion Test Coupons Exposed in REDOX 107-SX Process Waste Storage Tank [RM-148]*, HW-53308, General Electric Co., Richland, Washington.

Hanlon, B. M., 2002, *Waste Tank Summary Report for Month Ending February 28, 2002*, HNF-EP-0182, Rev. 167, prepared for the U.S. Department of Energy by CH2MHill Hanford Group, Inc., Richland, Washington.

Henager, C. H., et al., 1988, *Modeling of Time-Variant Concrete Properties at Elevated Temperatures*, PNL-7779, Pacific Northwest Laboratory, Richland, Washington.

Hookham, C. J., 1995, *In-Service Inspection Guidelines for Concrete Structures in Nuclear Power Plants*, ORNL/NRC/LTR-95/14, Prepared for the Oak Ridge National Laboratory and the U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research.

Jaske, R. T., 1955, *Evaluation of Soil Corrosion at Hanford Atomic Products Operation*, Summary Report – Underground Pipeline Structure Corrosion Study Program, HW-33911, General Electric, Richland, Washington.

Jaske, C. E, et al. 1994, *Life Assessment of Vessels and Piping Used to Transfer and Store Hazardous Fluids*, prepared for Westinghouse Hanford Company, sponsored by the American Society of Mechanical Engineers, Professional Development Department, New York, New York.

Julyk, L. J., 1994, *Tank 241-C-106 Structural Integrity Evaluation for In situ Conditions*, WHC-SD-W320-ANAL-001, Rev. 0 and 0A, Westinghouse Hanford Company, Richland, Washington.

Kaar, P. H., and D. C. Stark, 1979, *Effects of Waste Solutions on the Corrosion of Reinforcing Steel*, Progress Report No. 2 to Rockwell Hanford Operations, Submitted by Construction Technology Laboratories, A Division of the Portland Cement Association, Skokie, Illinois.

Kaar, P. H., and D. C. Stark, 1981, *Interim Report on the Effects of Waste Solutions on Reinforced Hanford Concrete*, RHO-C-52, Construction Technology Laboratories, A Division of the Portland Cement Association, Skokie, Illinois.

Kassir, M. K., et al. 1996, *Thermal Degradation of Concrete in the Temperature Range from Ambient to 315°C (600°F)*, BNL-52384, Brookhaven National Laboratory, Upton, New York.

Kirch, N. W., 1984, *Technical Basis for Waste Tank Corrosion Specifications*, SD-WM-TI-150, Rockwell Hanford Operations, Richland, Washington.

Lawler, J. H. L., 1983, *Aging Waste Operational Summary*, SD-WM-TI-073, Rockwell Hanford Operations, Richland, Washington.

Leader, G. R., and B. F. Faris, October 1945, *A Study of Decontamination Cycle Waste Solutions and Methods of Preparing Them for Disposal*, SE-PC-#82, HW-3-3220.

Mallet, G. R., 1954, *Corrosion Test of Mild Steel in REDOX Waste Tank*, HW-33552, General Electric Co., Richland, Washington.

Mclenegan, D. W., 1958, *Temperature Transients in Underground Tanks Storing Nuclear Process Residues*, HW-56821, General Electric Co., Richland Washington.

Mercier, P. F., et al. 1981, *Survey of the Single-Shell Tank Thermal Histories*, RHO-CD-1172, Rockwell International, Rockwell Hanford Operations, Energy Systems Group, Richland, Washington.

Naus, D. J., et al. 1996, *Report on Aging on Nuclear Power Plant Reinforced Concrete Structures*, NUREG/CR-6424, ORNL-NUREG-13148, Prepared for Division of Engineering Technology, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission

Ondrejcin, R. S., 1976, *Composition and Corrosiveness of Low-Activity Waste Supernates Stored at the Savannah River Plant*, DP-1427, Du Pont, Savannah River Laboratory, Aiken, South Carolina.

Ondrejcin, R. S., 1978, *Prediction of Stress Corrosion of Carbon Steels by Nuclear Process Liquid Wastes*, DP-1478, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, South Carolina.

Ondrejcin R. S., S. P. Rideout, and J. A. Donovan, 1979, "Control of Stress Corrosion Cracking in Storage Tanks Containing Radioactive Waste," *Nuclear Technology*, Vol. 44.

Payer, J. H., R. B. Diegle and Walter K Boyd, 1975, *Corrosivity of Synthetic Salt Cake*, ARH-C 22, Atlantic Richfield Hanford Co., Richland, Washington.

PCA 1989, *Effects of Substances on Concrete and Guide to Protective Treatments*, Portland Cement Association, Skokie, Illinois.

Peterson, W. S. 1994, *Evaluation of Strength and Modulus Degradation Due to Temperature Effects on Hanford Concrete*, WHC-SD-WM-DA-153, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Pitzer, E. C., 1952, *Corrosion Testing – SAE 1010 Mild Steel in Synthetic Metal Waste Solution*, HW-24136.

Poe, W. L., 1974, *Leakage from Waste Tank 16 Amount, Fate, and Impact*, DP-1358, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, South Carolina.

Sanborn, K. L., November 1949, *A Survey of Corrosion Data and Construction Details*, 200 Area Waste Storage Tanks, HW-14946.

Sanborn, K. L., November 1952, *A Study of the Effect of pH of First Cycle Bismuth Phosphate Waste on the Corrosion of Mild Steel*, HW-26202.

Sarafian, P. G., 1975, *The Influence of Microstructure on Stress Corrosion Cracking of Mild Steel in Synthetic Caustic-Nitrate Nuclear Waste Solution*, A Thesis Presented to The Faculty of the Division of Graduate Studies and Research, Georgia Institute of Technology, Georgia.

Stark, D. C., Aug. 1976, *Final Report, Special Agreement SA-202 Prime Contract, AT (45-1)-2130*, to Atlantic Richfield Hanford Co., Richland, Washington, ARH-R-217, from Portland Cement Association, Skokie Illinois.

Troxell, G. E., and H. E. Davis, 1956, *Composition and Properties of Concrete*, McGraw-Hill Civil Engineering Series, McGraw-Hill Book Company, New York, New York.

UTRM 1951, *Uranium Recovery Technical Manual*, HW-19140, General Electric Co., Richland Washington.

Walker, W. L., 1958, *The Effect of High Temperatures on the Corrosion of Underground Waste Storage Tanks Liners*, HW-56373, General Electric Co., Richland, Washington.

Ward, R., 1953, *Technical Activities Report Metallurgy – Applied Research Unit*, HW-27097, Hanford Structural Materials, Section IV and VI.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-TI-356, Vol. 1 and 2, Westinghouse Hanford Co., Richland, Washington.

Winkel, B. V., 1995, *Concrete Material Characterization, Reinforced Concrete Tank Structure, Multi-Function Waste Tank Facility*, Project W-236A, WHC-SD-W236A-ER-013, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank.

APPENDIX G

SINGLE-SHELL TANK STRUCTURAL ANALYSES

Prepared by: M. R. Lindquist Date: 6/6/02

Reviewed by: L. J. Julyk Date: 6/10/02

J. T. Baxter Date: 6/10/02

This page intentionally left blank.

TABLE OF CONTENTS

TABLES

LIST OF TRADEMARKS

ABAQUS is trademark of Hibbitt, Karlsson & Sorensen, Inc., Pawtucket, Rhode Island.

ANSYS is trademark of Swanson Analysis Systems, Inc., Houston, Pennsylvania.

SAFE-CRACK is trademark of ANATECH Research Corporation, San Diego, California.

APPENDIX G

SINGLE-SHELL TANK STRUCTURAL ANALYSES

G1.0 OBJECTIVE

This appendix supports, in part, the requirements set forth in paragraph A of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Milestone M-23-24. Specifically, this appendix addresses "presentation of all calculations employed to determine each structures design strength, and useful life…" for the single-shell tanks (SSTs). A corresponding presentation for SST pits and transfer lines is contained in Appendix B. The SST steel liner provides a leak barrier for the stored waste and the reinforced concrete shell provides the load-bearing structure to resist internal and external loads acting on the tank. The steel liner is not relied on as a structural load-bearing component by design; hence it is not addressed in this appendix. Liner leak integrity is addressed in Appendices A, D, E, and F.

G2.0 APPROACH

The original design calculations for the SSTs have not been recovered to date. However, post-construction structural evaluations that address more severe operating conditions than considered in the original design requirements have been retrieved and were reviewed in *Load Requirements for Maintaining Structural Integrity of Hanford Single-Shell Tanks During Waste Feed Delivery and Retrieval Activities* (HNF-4712, 1999). Brief summaries of the reports reviewed in HNF-4712 are provided herein. In addition, seven of the more significant reports were selected for more in-depth review and detailed summary.

G3.0 CONCLUSIONS

The following conclusions are drawn from the review of post-construction structural analyses.

- The structural analyses that have been performed on the SSTs over the years have all reached the same general conclusion that the tanks are not in danger of collapse for the conditions experienced by the SSTs. Rigorous analyses including the effects of material aging, thermal loading, temperature effects on concrete properties, and concrete creep have concluded that the tank design is adequate for the loading environment that exists on the tanks. Collapse margin factors[1] for the 75-foot-diameter tanks (100-series) have been analytically predicted in the range of 3 to 4.8 (SD-RE-TI-012. 1983 and WHC-SD-W320-ANAL-001, 1995 respectively).

- Analyses performed on the 20-foot-diameter tanks (200-series) found them to be structurally adequate for soil overburden, hydrostatic, and seismic loading (SD-RE-TI-012, 1983). No additional analyses have been performed on the 20-foot-diameter tanks, because they were not exposed to high temperatures, were taken out of service, and no changes in their operational conditions have occurred.

- The significant areas for the concrete structure with regard to American Concrete Institute code compliance are the footing at the base of the tank and the tank dome. Sensitivity studies have shown that loads over the dome (soil depth, soil density, and concentrated loads) have the greatest influence on the stresses at these critical tank locations.

- Liner leak integrity and the potential effects of leaks on the concrete structural integrity are not within the scope of the analyses described in this appendix. The collapse margin conclusions did not consider potential structural degradations associated with caustic chemical damage and rebar corrosion, which are addressed in Appendix F. However, for tanks that have leaked, if major structural damage to the lower area of the tanks would have occurred, it is expected that dome deflection measurements would have reflected this condition. No anomalous dome deflection measurements have been identified to date (see Appendix E).

- Post-design seismic evaluations have indicated that the SSTs are adequate for current site seismic requirements.

- Operating limits for maintaining structural integrity (temperature, temperature rate of change, temperature differentials, tank pressures, pressure rate of change, and dome loading) were proposed for retrieval activities in HNF-4712. These requirements are consistent with current load restrictions except for the heat-up/cool-down rate of temperature change, which is more restrictive in HNF-4712. Heat-up/cool-down rate of temperature change is not an issue for current SST operation mode since no new waste can be added to the SSTs. Current operating limits are therefore adequate for maintaining structural integrity.

---

[1] Based on dome collapse due to soil loading after thermal-creep period compared to normal in-place soil loading.

G4.0 BRIEF SUMMARY OF STRUCTURAL ANALYSES

Extensive documentation and analyses have been performed over the years in support of SST design, operations, safety bases, and integrity. Although some of the reports date to the 1940s, most of the useable detailed analyses that have been recovered are from the 1960s to the present. No records have been found relating to the calculations that substantiate the original design of the tanks.

HNF-4712 contains, in part, the results of an extensive survey and review of all significant available documents related to SST structural integrity.

A brief summary of the supporting analysis reports that were reviewed in HNF-4712 is presented in Table G.1. For each document the table lists the date of analysis, the tanks affected, the basis for the analyses, and conclusions related to structural integrity.

Table G.1. Brief Summaries of Single-Shell Tank Supporting Analysis Documents (5 Sheets)

Document	Date	Author	Tanks Affected	Basis for Performing the Analyses	Structural Integrity Related Conclusions
HW-37519, *Structural Evaluation Underground Waste Storage Tanks.*	1955	E. F. Smith	100-series SSTs, except AX	There was a need to establish limiting values of internal pressure and waste specific gravity.	An evaluation was performed to determine the influence of internal pressure and waste specific gravity resulting from waste self-concentration. Limiting values on specific gravity and vapor pressure were recommended and implemented. These limiting values predicted some local cracking of the concrete which may result in a potential leak path to the soil if the liner fails. Collapse of the tank was not considered possible under the assumed loading.
HW-57274, *Instability of Steel Bottoms in Waste Storage Tanks.*	1958	L. E. Brownell	SX-113	The bottom of this tank buckled, and then returned to the original position. Analysis was performed to determine the cause of the buckling.	The report presents a theory for buckling of the tank bottom and suggests possible design changes including venting of the liner bottom and increased radius on the liner wall/base intersection. Buckling of tank bottom could result in liner leakage, but would not affect tank structural collapse. The AX tanks were built after this report was written and the design did have a 4 to 8 in. radius at the liner wall/bottom intersection.
HW-59919, *Limitations for Existing Storage Tanks for Radioactive Wastes form Separation Plants.*	1959	E. Doud, H. W. Stivers	A, SX, BY, S,TX, TY, B, BX, C, T, U	The structural integrity of the tank was assessed by analyzing tanks against the then current PCA and ACI codes.	Allowable load curves were established which were less than the full capacity liquid levels. Structural integrity was assured since current PCA and ACI codes were satisfied.
RL-UPO-12, *Structural Evaluation of Existing 241 Waste Storage Tanks for Waste Solidification Program.*	1965	E. F. Smith	"Existing" waste storage tanks	The same approach was used as HW-59919 except vapor pressure in the tank was assumed to be no greater than atmospheric.	Allowable load curves were established which superceded HW-59919. This analysis concluded that the tanks had a higher load capacity than concluded in HW-59919.

Table G.1. Brief Summaries of Single-Shell Tank Supporting Analysis Documents (5 Sheets)

Document	Date	Author	Tanks Affected	Basis for Performing the Analyses	Structural Integrity Related Conclusions
HN-197, *Report of Study of Hanford Waste Tank Structures.*	1968	Holmes and Narver, Inc.	Existing and proposed waste storage tanks	This report provided a third party review of all structural analyses to date.	The report concluded that the original tank design appears reasonable. Local cracking as a result of thermal effects was identified as a possibility. Some tanks have been subjected to higher temperatures (see Appendix A) than the original design (which was 250 °F). The nominal design margin is approximately 60%; therefore, some increase in thermal effects may be accommodated. The local cracks could affect leakage through the concrete, but not collapse of the tank.
ARH-R-45, *Interim Summary Report, Stress and Strength Analysis for Waste Tank Structures at Hanford Washington.*	1969	K. P. Milbradt	A, AX, SX, BY, BX	There was a desire to fill the tanks to higher levels using soil pressure to counteract hydrostatic head.	The analysis defined the state of stress and potential for cracking using elastic thin shell analysis. Operating thermal histories were used. All but the BX tanks indicated possible cracking at the junction between vertical wall and footing. It was concluded that this could lead to leakage, but would not lead to tank collapse.
ARH-2883, *Creep and Cracking Analysis of the 241-BY-112 Reinforced Concrete Underground Waste Storage Tank.*	1973	F. R. Vollert	BY	The analysis studied creep effects at 250 ^{O}F and 280 ^{O}F. The SAFE-CRACK computer code was used for the analysis.	Stresses were found to be acceptable, although cracks might appear in the dome haunch and lower wall. Creep and cracking were found to be self-limiting over the 1,900 day duration of the analysis. Cracks could affect leakage through the concrete, but not collapse of the tank.
ARH-C-11, *Thermal-Creep and Ultimate Load Analysis of 241-AX Structure.*	1976	Y. R. Rashid	AX	This analysis evaluated a new temperature history that reached 350 ^{O}F.	Thermal-creep analysis predicted some cracking of the dome and lower portion of wall. After 10 years of creep, a concentrated load was applied to the dome and the soil weight over the dome was increased. The ultimate strength of the dome was reached with a factor of 3.5 applied to 8 ft of soil (current limit is 10 ft of soil). Predicted cracks could affect leakage through the concrete, but not collapse of the tank.

Table G.1. Brief Summaries of Single-Shell Tank Supporting Analysis Documents (5 Sheets)

Document	Date	Author	Tanks Affected	Basis for Performing the Analyses	Structural Integrity Related Conclusions
RHO-R-6, *Analysis of Underground Waste Storage Tanks 241-AX at Hanford, Washington.*	1978	URS/John A. Blume & Associates	AX	The report assesses the ability of the tanks to structurally maintain leak integrity after 14 years of use. Seismic (0.25g) plus thermal-creep analysis was performed.	The stresses were found to be acceptable; however, there are limitations in the analyses regarding thermal histories and material properties that were used. (Some of these limitations are addressed in WHC-SD-W320-ANAL-002, C-106 analysis.)
RHO-SA-108, *Structural evaluation of Existing Underground Reinforced Concrete Tanks for Radioactive Waste Storage.*	1979	F. R. Vollert	U	A creep and ultimate load analysis was performed with a maximum waste temperature of 350 ^{O}F.	The creep analysis was conducted for 10 years of time. Creep and cracking were stationary at the end of the 10-year period. Soil height was increased in the analysis until ACI limits on compressive strength of wall were reached. This occurred with a soil height of approximately 20 ft above the tank dome.
SD-RE-TI-012, *Single-Shell Waste Tank Load Sensitivity Study.*	1983	A. L. Ramble	All SSTs	This document is the basis for the current SST structural related operating limits. Thermal creep and ultimate load analyses were performed. Load/structure sensitivity analyses also performed.	Structural integrity related conclusions are presented in Table G.2.
WHC-SD-WM-DA-150, *Structural Sensitivity Evaluation of Single- and Double-Shell Waste Storage Tanks for Accelerated Safety Analysis – Phase I.*	1994	W. W. Chen, W. S. Peterson, L. L. Hyde, C. J. Moore, T. W. Fisher	100-series	This analysis was performed for the SST accelerated safety analysis. Tank stress sensitivity to various load parameters was determined.	Structural integrity related conclusions are presented in Table G.2.

Table G.1. Brief Summaries of Single-Shell Tank Supporting Analysis Documents (5 Sheets)

Document	Date	Author	Tanks Affected	Basis for Performing the Analyses	Structural Integrity Related Conclusions
WHC-SD-WM-TI-623, *Static Internal Pressure Capacity of Hanford Single-Shell Waste Tanks*	1994	ADVENT Engineering Services	530,000 and 1 million gal generic SSTs	This report determined the onset-to-failure from static internal pressure. The ABAQUS computer code was used in the analysis.	Pressure increase of 14 and 11.6 psig vapor pressure for 530,000 and 1 million gal SST, respectively are required to produce dome failure. Permanent structural damage is likely to occur before failure pressures are reached.
WHC-SD-W320-ANAL-001, *Tank 241-C-106 Structural Integrity Evaluation for In situ Conditions.*	1995	L. J. Julyk, et al.	C-106	This report evaluated the structural integrity to ACI criteria and estimated reserve capacity to ultimate load. An upper bound thermal history was used (bounds all 530,000 gal 100-series tanks). Mismatch between the thermal expansion of steel and Hanford concrete was considered in the analysis.	Structural integrity related conclusions are presented in Table G.2.
Report No. 941101-001, *Review and Parametric Studies for Tank 241-C-106 Dome Structure.*	1994	A. Ghose	C-106	The purpose of the analysis was an evaluation of "irregularities" in the dome undersurface that were observed on video.	It was believed that the irregularities were the result of plywood form sheets used during construction. However, cracks were modeled in the analysis. It was concluded that the existing tank C-106 analysis was adequate and that the perceived dome irregularities have no impact on structure.
WHC-SD-W320-ANAL-002, *Seismic Evaluation of Tank 241-C-106 in Support of Retrieval Activities.*	1995	D. A. Wallace	C-106	A seismic analysis (0.2g peak horizontal acceleration) was performed using the in situ loading history of WHC-SD-W320-ANAL-001.	Structural integrity related conclusions are presented in Table G.2.

Table G.1. Brief Summaries of Single-Shell Tank Supporting Analysis Documents (5 Sheets)

Document	Date	Author	Tanks Affected	Basis for Performing the Analyses	Structural Integrity Related Conclusions
WHC-SD-W320-ANAL-003, *Tank 241C106 Structural Evaluation in Support of Project W320 Retrieval.*	1995	D. A. Wallace, et al.	C-106	The report presents an evaluation of loads imposed upon tank during retrieval operations.	Structural integrity related conclusions are presented in Table G.2.
WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks.*	1996	F. C. Han	All SSTs	This report presents a review of all existing analyses as a basis for the consequence analysis in the tank farms safety analysis.	Structural integrity related conclusions are presented in Table G.2.
RLCA, *Evaluation of Hanford High Level Waste Tank Failure Modes for Seismic Loading.*	1996	Robert L. Cloud & Associates	All SSTs	This is an independent review of assumptions of WHC-SD-TWR-RPT-003 (seismic failure).	The conclusions of the report agreed with WHC-SD-TWR-RPT-003. SSTs have a safety factor of approximately 3 compared to current seismic design requirements.
HNF-4712, *Load Requirements for Maintaining Structural Integrity of Hanford Single Shell Tanks During Waste Feed Delivery and Retrieval Activities.*	1999	L. J. Julyk	All SSTs, with emphasis on lead retrieval tanks C-102 and C-104	Structural integrity (load bearing) requirements are addressed for Phase 1 and Phase 2 retrieval and transfer to vitrification plant. Waste leakage integrity is not addressed.	Structural integrity related conclusions are presented in Table G.2.

ACI = American Concrete Institute.
PCA = Portland Cement Association.
SST = single-shell tank.

G5.0 STRUCTURAL ANALYSES SELECTED FOR DETAILED REVIEW

HNF-4712 provides the basis for the 1999 position on SST structural integrity and sets limits for future retrieval operations. HNF-4712 does not provide any new analysis, but rather establishes conclusions based on earlier work. Seven of the more significant structural integrity related reports reviewed in HNF-4712 were selected for more detailed review, including HNF-4712 itself. These structural evaluations are relatively recent and address the SSTs for past and current conditions from the viewpoint of current codes and standards. As such, they provide significant insight relative to the current structural integrity of the SSTs. Significant structural-integrity-related conclusions, extracted from these seven reports, are provided in Table G.2. These seven reports are:

- SD-RE-TI-012, 1983, *Single-Shell Waste Tank Load Sensitivity Study.*
- WHC-SD-WM-SARR-012, 1994, *Accelerated Safety Analyses – Structural Analyses Phase I – Structural Sensitivity Evaluations of Single and Double Shell Waste Storage Tanks.*
- WHC-SD-W320-ANAL-001, 1995, *Tank 241-C-106 Structural Integrity Evaluation for In-situ Conditions.*
- WHC-SD-W320-ANAL-002, 1995, *Seismic Evaluation of Tank 241C106 in Support of Retrieval Activities.*
- WHC-SD-W320-ANAL-003, 1995, *Tank 241C106 Structural Evaluation in Support of Project W320 Retrieval.*
- WHC-SD-TWR-RPT-002, 1998, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks.*
- HNF-4712, 1999, *Load Requirements for Maintaining Structural Integrity of Hanford Single-Shell Tanks During Waste Feed Delivery and Retrieval Activities.*

Table G.2. Structural Integrity Conclusions from the More Significant Structural Evaluation Reports (3 Sheets)

Document	Tanks Affected	Structural Integrity Analysis Summary and Conclusions
SD-RE-TI-012, *Single-Shell Waste Tank Load Sensitivity Study*, 1983, A. L. Ramble.	All SSTs	• This document is the basis for the current SST structural related operating limits. Current operating limits are equal to or more restrictive than those recommended in this report. • The report determined, through analyses using the ANSYS code, the structural sensitivity of the tanks to soil backfill loads, equipment loads, hydrostatic loads and elevated temperatures. • An empty tank and a tank filled with liquid (2.0 specific gravity) were analyzed. • All tanks were quite insensitive to changes in the equipment or hydrostatic loads. In all tanks, the section with the highest stresses was the footing. The tank wall was assumed to be hinged at the footing, which may be unconservative. The dome could withstand two to three times the soil load that could be carried by the footing area, depending on the footing design. For all loading cases, the calculated stresses were within the allowable stresses per ASME Section III, Division 2 of the ASME B&PVC criteria. • A worst-case temperature distribution for the 1 million gal tanks was based on the thermal analysis of tank A-106. This resulted in a high base temperature, a steep gradient in the lower wall, and uniform temperatures across the dome. Some cracking in the lower wall can be expected to have occurred, but yielding of the reinforcing steel was not indicated. Although this is not a recommended operating condition, the indicated damage of the concrete tank was not expected to be appreciable. • The 55,000 gal tanks (20 ft diameter) were found to be structurally adequate for their existing soil overburden and hydrostatic loads. Since these tanks have not experienced elevated temperatures, temperature degradation of the structure is not an issue for these tanks. • Structural reserve capacity of the tanks is not exceeded with loading from 0.25g SSE (safe shutdown earthquake). • Tank collapse was not predicted by the analysis, however leak-tightness cannot be assured since the steel liner was not analyzed. Safety factor against collapse due to soil loads at the end of the creep period is approximately 3 (75 ft diameter tank).
WHC-SD-WM-SARR-012, *Accelerated Safety Analyses – Structural Analyses Phase I – Structural Sensitivity Evaluations of Single- and Double-Shell Waste Storage Tank*, 1994, D. L. Becker and L. L. Hyde.	100-series	• This analysis was performed in support of the SST accelerated safety analysis. • Structural sensitivity analyses were performed to assess the response of SSTs to variations in loading conditions and uncertainties in loading and material parameters. • The parameters that most greatly affected dome stresses were concentrated loads, soil depth and soil density. • The parameters that most greatly affected footing stresses were soil depth and soil density. • Soil stiffness variations under the tanks had a large effect upon the foundation stresses. • It was concluded that no changes in operating parameters are needed to maintain the structural integrity of the tanks. • Continuing dome deflection measurements were recommended.

Table G.2. Structural Integrity Conclusions from the More Significant Structural Evaluation Reports (3 Sheets)

Document	Tanks Affected	Structural Integrity Analysis Summary and Conclusions
WHC-SD-W320-ANAL-001, *Tank 241-C-106 Structural Integrity Evaluation for In situ Conditions*, 1995, L. J. Julyk, et al.	C-106	• This was a major effort to qualify the tank using state-of-the-art finite element analysis methods. • This report assessed the high-heat tank C-106 using its thermal history and calculated the reserve capacity of the structure at the end of the creep period. • An upper bound thermal history for the tank was developed based upon available data. • The ultimate load analysis was benchmarked against 1:10 scale concrete tank model tests (ARH-R-47, 1969). • The observed mismatch between the thermal expansion of steel and Hanford concrete was modeled. • Nominal loads were applied to the tank and at the end of the creep time the structure satisfied ACI 349 criteria. • Revision 0A of this document considered revised soil density of 125 lbf/ft^3. All tank locations met ACI 349 concrete design criteria. • The results are specific to tank C-106 but can be considered to envelope the 530,000 gal SSTs (B, C, T, U, and BX) since these tanks are the same design. • In the model, a concentrated load was applied in the center of the dome and the soil load above the dome was increased after the thermal-creep period until failure of the concrete was predicted. A minimum safety factor of 4.8 was predicted. • Tank collapse was not predicted by the analysis; however, leak-tightness cannot be assured since the steel liner was not evaluated for potential corrosion related failure modes.
WHC-SD-W320-ANAL-002, *Seismic Evaluation of Tank 241-C-106 in Support of Retrieval Activities*, 1995, D. A. Wallace.	C-106	• This was a major effort using state-of-the-art finite element modeling and soil-structure interaction methods. • A 0.2g ZPA (zero period acceleration) spectra used in the analyses. • The seismic effect of tank-to-tank interaction would be relatively small would vary with location. • The greatest effect of vertical excitation relative to horizontal would be in the dome. • The major seismic effect of 100 ton live load mass would be circumferential moment near dome apex. • Revision 0A of this document considered revised soil density of 125 lbf/ft^3. All tank locations met ACI 349 concrete design criteria. • The results are specific to tank C-106 but can be considered to envelope the 530,000 gal SSTs (B, C, T, U, and BX) since these tanks are the same design. • Tank collapse was not predicted by the analysis; however, leak-tightness cannot be assured since the steel liner was not analyzed.
WHC-SD-W320-ANAL-003, *Tank 241C106 Structural Evaluation in Support of Project W320 Retrieval*, 1995, D. A. Wallace, et al.	C-106	• This analysis considered the added loading on the tank associated with retrieval activities. • In situ soil conditions were used for the tank qualification. • The tank satisfies ACI 349 design criteria for concrete for non-seismic loads associated with retrieval. • Tank collapse was not predicted by the analysis; however, assurance against leakage cannot be assured since the steel liner was not evaluated for potential corrosion related failure modes.

Table G.2. Structural Integrity Conclusions from the More Significant Structural Evaluation Reports (3 Sheets)

Document	Tanks Affected	Structural Integrity Analysis Summary and Conclusions
WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tank*, 1996, F. C. Han.	All SSTs	• Tank structural integrity was assessed by review of existing documents. Potential failure modes were estimated using existing data, hand calculations, and engineering judgment. • It was concluded that SSTs are adequate for normal operating loads with current restrictions in place and that SSTs have considerable safety margin for concentrated and uniform loads above the tanks. • The report identifies corrosion as a major issue for the steel liner. • Tank collapse was not predicted by the analysis; however, assurance against leakage cannot be assured since the steel liner was not evaluated for potential corrosion related failure modes.
HNF-4712, *Load Requirements for Maintaining Structural Integrity of Hanford Single Shell Tanks During Waste Feed Delivery and Retrieval Activities*, 1999, L. J. Julyk.	All SSTs, with emphasis on lead retrieval tanks C-102 and C-104.	• The report reviews existing structural documentation to assure that tank structural integrity is maintained during SST Phase 1 and Phase 2 retrieval. • Limits are recommended for tank temperatures, waste levels, vapor pressure, and dome loading to maintain structural integrity during tank retrieval. • Recommended load limits are the same as current restrictions except for the heat-up/cool-down rate of temperature change. • Tank collapse was not predicted by the analysis; however ,assurance against leakage cannot be assured since the steel liner was not evaluated for potential corrosion related failure modes.

SST = single-shell tank.

G6.0 SUMMARY OF STRUCTURAL INTEGRITY EVALUATIONS

The construction period for the SSTs extended from 1943 to 1964. During that time, codes and standards for structural design changed. For example, no seismic criteria were in place for the earlier tank designs. The first tanks that clearly included seismic loading in their design criteria were the AX farm tanks in 1963.

Analytical techniques and calculation tools have also evolved over the years from classic hand computation methods to state-of-the-art finite element analysis methods. The more recent structural analysis methodology permits addressing relatively complex material properties (concrete aging and creep effects), thermal histories and gradients, loading profiles, detailed geometry, and complex boundary conditions of the structure.

Data on the specific properties of Hanford concrete (especially thermal effects) have been measured and developed over the years (see Appendix F). The most current concrete data were incorporated into the analyses of the SSTs as they were performed. Most recent analyses utilize a concrete model that is based on correlations of all data developed to date.

Operational conditions of the tanks have exceeded original design requirements, which necessitated the need for further analyses. In addition, detailed thermal histories, through-wall temperature gradients, creep effects, and seismic loading were not included in early calculations, leading to more detailed analyses to evaluate these conditions.

More recent structural evaluations have concentrated on the 75-foot-diameter tanks (100-series) because these tanks have had operational loading condition changes that exceeded their original design requirements. Analyses (SD-RE-TI-012, 1983) performed on the 20-foot-diameter tanks (200-series) found them to be structurally adequate for soil overburden, hydrostatic, and seismic loading at the time of the analysis. No additional analyses have been performed on the 20 foot diameter tanks, because they were not exposed to high temperatures, were taken out of service, and no changes in their operational conditions has occurred. These tanks were not exposed to high temperatures either during service or after the time that they were taken out of service.

An empty tank represents a special loading condition. This was addressed in the analysis reported in SD-RE-TI-012, which considered two enveloping hydrostatic conditions. These were an empty tank and a tank filled to maximum design capacity with a liquid of specific gravity of 2.0. The analysis concluded that the tanks have adequate capacity to resist all applied soil and thermal loads.

The scope of the analyses described in this appendix did not include the effects of stored waste corrosion on steel liner leak integrity. These effects are discussed in Appendix F.

In the early period of tank operations, an anomalous condition occurred in some tanks in which the steel liner tank bottom bulged upward. For tanks where the bottoms bulged, the structural condition of the tank was assessed and the tank was taken out of service, as appropriate. Evaluations related to tank bulging are reported in the following:

- HW-57274, 1958, *Instability of Steel Bottoms in Waste Storage Tanks* (1958)
- RL-SEP-630, *105-A Waste Storage Tank Model Test* (1965)
- ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and Implication on Waste Containment and Control* (1967).

The margin of safety against dome collapse was investigated in ARH-R-47, *Model Tests of Waste Disposal Tanks* (1969), which discusses the results of a 1:10-scale model collapse load test for the A farm tank design. Results from the 1:10-scale model test were used in WHC-SD-W320-ANAL-001 (1995) to benchmark the analytical finite element model developed for the analysis of the "high-heat" tank C-106.

G7.0 REFERENCES

ARH-78, 1967, *PUREX TK-105-A Waste Storage Tank Liner Instability and Implication on Waste Containment and Control*, by S. J. Beard, P. Hatch, G. Jansen, and E. C. Watson, Jr., Atlantic Richfield Hanford Company, Richland, Washington

ARH-2883, 1973, *Creep and Cracking Analyses of the 241-BY-112 Reinforced Concrete, Underground Waste Storage Tank*, F. R. Vollert, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-C-11, 1976, *Thermal-Creep and Ultimate Load Analysis of 241-AX Structure*, prepared by Y. R. Rashid, ANATECH Research Corporation, San Diego, California for Atlantic Richfield Hanford Company, Richland, Washington.

ARH-R-45, 1969, *Interim Summary Report, Stress and Strength Analysis for Waste Tank Structures at Hanford Washington*, K. P. Milbrandt, Illinois Institute of Technology, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-R-47, 1969, *Model Tests of Waste Disposal Tanks*, by D. McHenry and O. C. Guedelhoefer, Wiss, Janney, Elstner and Associates, Northbrook, Illinois for Atlantic Richfield Hanford Company, Richland, Washington.

ARH-R-120, 1972, *Final Report: Strength and Stress Analysis for Waste Tank Structures at Hanford, Washington*, prepared by K. P. Milbradt, Department of Civil Engineering, Illinois Institute of Technology for Atlantic Richfield Hanford Company, Richland, Washington.

HN-197, 1968, *Report of Study of Hanford Waste Tank Structures*, prepared by Holmes & Narver, Inc., Los Angeles, California for Atlantic Richfield Hanford Company, Richland, Washington.

HNF-4712, 1999, *Load Requirements for Maintaining Structural Integrity of Hanford Single-Shell Tanks During Waste Feed Delivery and Retrieval Activities*, Rev. 0, L. J. Julyk, Lockheed Martin Hanford Corporation, Richland, Washington.

HW-37519, 1955, *Structural Evaluation Underground Waste Storage Tanks*, by E. F. Smith, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

HW-57274, 1958, *Instability of Steel Bottoms in Waste Storage Tanks*, by L. E. Brownell, General Electric-Hanford Atomic Products Operation, Richland, Washington.

HW-59658, 1959, *Heat Transfer Study for Self-Boiling Radioactive Wastes*, by H. W. Stivers and G. R. Taylor, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

HW-59919, 1959, *Limitations for Existing Storage Tanks for Radioactive Wastes from Separation Plants*, by E. Doud and H. W. Stivers, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

Report No. 941101-001, 1994, *Review and Parametric Studies for Tank 241-C-106 Dome Structure*, Rev. 0, prepared by A. Ghose, ARES Corporation for Westinghouse Hanford Company, Richland, Washington.

RHO-R-6, 1978, *Analysis of Underground Waste Storage Tanks 241-AX at Hanford, Washington*, prepared by URS/John A. Blume & Associates, Engineers, San Francisco, California for Vitro Engineering, Richland, Washington.

RHO-SA-108, 1979, *Structural Evaluation of Existing Underground Reinforced Concrete Tanks for Radioactive Waste Storage*, F. R. Vollert, Rockwell Hanford Operations, Richland, Washington.

RLCA, 1996, *Evaluation of Hanford High Level Waste Tank Failure Modes for Seismic Loading*, prepared by Robert L. Cloud & Associates, Inc., Berkeley, California for U.S. Department of Energy - RL, Richland, Washington.

RL-SEP-630, 1965, *105-A Waste Storage Tank Model Test*, by D. D. Wodrich, General Electric Hanford Atomic Products Operation, Richland, Washington.

RL-UPO-12, 1965, *Structural Evaluation of Existing 241 Waste Storage Tanks for Waste Solidification Program*, by E. F. Smith, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

SD-RE-TI-012, 1983, *Single-Shell Waste Tank Load Sensitivity Study*, Rev. A-0, A. L. Ramble, Rockwell Hanford Operations, Richland, Washington.

SD-RE-TI-037, 1982, *Tank 241-A-106 Steady-State Heat Transfer Analysis*, Rev. 0, by K. E. Bruce, Rockwell Hanford Operations, Richland, Washington.

WHC-SD-W320-ANAL-001, 1995, *Tank 241-C-106 Structural Integrity Evaluation for In situ Conditions*, Rev. 0 and 0A, L. J. Julyk, et al., Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W320-ANAL-002, 1995, *Seismic Evaluation of Tank 241C106 in Support of Retrieval Activities*, Rev. 0 and 0A, D. A. Wallace, et al., Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W320-ANAL-003, 1995, *Tank 241C106 Structural Evaluation in Support of Project W320 Retrieval*, Rev 0 and 0A, D. A. Wallace, et al., Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DA-150, 1994, *Structural Sensitivity Evaluation of Single- and Double-Shell Waste Storage Tanks for Accelerated Safety Analysis - Phase I*, Rev. 0, by W. W. Chen, W. S. Peterson, L. L. Hyde, C. J. Moore, and T. W. Fisher, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ES-286, 1994, *Single- and Double-Shell Tanks Load Report for Accelerated Safety Analysis*, Rev. 0, by D. L. Becker, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-012, 1994, *Accelerated Safety Analyses – Structural Analyses Phase I – Structural Sensitivity Evaluations of Single and Double Shell Waste Storage Tanks*, Rev. 1, D. L. Becker and L. L. Hyde, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-623, 1994, *Static Internal Pressure Capacity of Hanford Single-Shell Waste Tanks*, Rev. 0, prepared by ADVENT Engineering Services, Inc. for Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-775, 1996, *Structural Assessment of Accident Loads*, Rev. 0, by G. R. Wagenblast, ICF Kaiser Hanford Company for Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TWR-RPT-002, 1998, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, Rev. 0-A, F. C. Han, Lockheed Martin Hanford Company, Richland, Washington.

WHC-SD-TWR-RPT-003, 1996, *DELPHI Expert Panel Evaluation of Hanford High Level Waste Tank Failure Modes and Release Quantities*, Rev. 0, by F. C. Han, (complied and edited by L. Leach, independent consultant), Westinghouse Hanford Company, Richland, Washington.

APPENDIX H

SINGLE-SHELL TANK FACILITY LIST

Prepared by: ______________________ Date: 6/10/02
P. C. Miller

Reviewed by: ______________________ Date: 06/10/02
P. F. Kison

This page intentionally left blank.

APPENDIX H

SINGLE-SHELL TANK FACILITY LIST

The single-shell tank (SST) facility list in RPP-10466 (2002) is divided into two major parts. The first part includes all SST facilities that are "in-use," which includes all SST facilities currently identified as having a current of future mission. The second part includes all other SST facilities that are "inactive/not-in-use," which have no currently identified future mission. The in-use SST facilities (includes all 100- and 200-series SSTs and associated in-use ancillary equipment) are within the scope of the integrity assessment presented in this report and are listed in Table H.1. The not-in-use facilities listed in Table H.2 are not within the scope of this integrity assessment and will be addressed in the SST system *Resource Conservation and Recovery Act of 1976* closure plan.

REFERENCE

RPP-10466, 2002, *Status of Facilities and Waste Transfer Lines within Single-Shell Tank Farm*, Rev. 2, P. Kison and M. R. Koch, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table H.1. In-Use Facilities (Page 1 of 7)

A. Single-Shell Tank Facilities

Facility Number	Description
241-A-101	100-Series SST
241-A-102	100-Series SST
241-A-103	100-Series SST
241-A-104	100-Series SST
241-A-105	100-Series SST
241-A-106	100-Series SST
241-AX-101	100-Series SST
241-AX-102	100-Series SST
241-AX-103	100-Series SST
241-AX-104	100-Series SST
241-B-101	100-Series SST
241-B-102	100-Series SST
241-B-103	100-Series SST
241-B-104	100-Series SST
241-B-105	100-Series SST
241-B-106	100-Series SST
241-B-107	100-Series SST
241-B-108	100-Series SST
241-B-109	100-Series SST
241-B-110	100-Series SST
241-B-111	100-Series SST
241-B-112	100-Series SST
241-B-201	200-Series SST
241-B-202	200-Series SST
241-B-203	200-Series SST
241-B-204	200-Series SST
241-BX-101	100-Series SST
241-BX-102	100-Series SST
241-BX-103	100-Series SST
241-BX-104	100-Series SST
241-BX-105	100-Series SST
241-BX-106	100-Series SST
241-BX-107	100-Series SST
241-BX-108	100-Series SST
241-BX-109	100-Series SST
241-BX-110	100-Series SST
241-BX-111	100-Series SST
241-BX-112	100-Series SST
241-BY-101	100-Series SST
241-BY-102	100-Series SST

Table H.1. In-Use Facilities (Page 2 of 7)

A. Single-Shell Tank Facilities (Continued)

Facility Number	Description
241-BY-103	100-Series SST
241-BY-104	100-Series SST
241-BY-105	100-Series SST
241-BY-106	100-Series SST
241-BY-107	100-Series SST
241-BY-108	100-Series SST
241-BY-109	100-Series SST
241-BY-110	100-Series SST
241-BY-111	100-Series SST
241-BY-112	100-Series SST
241-C-101	100-Series SST
241-C-102	100-Series SST
241-C-103	100-Series SST
241-C-104	100-Series SST
241-C-105	100-Series SST
241-C-106	100-Series SST
241-C-107	100-Series SST
241-C-108	100-Series SST
241-C-109	100-Series SST
241-C-110	100-Series SST
241-C-111	100-Series SST
241-C-112	100-Series SST
241-C-201	200-Series SST
241-C-202	200-Series SST
241-C-203	200-Series SST
241-C-204	200-Series SST
241-S-101	100-Series SST
241-S-102	100-Series SST
241-S-103	100-Series SST
241-S-104	100-Series SST
241-S-105	100-Series SST
241-S-106	100-Series SST
241-S-107	100-Series SST
241-S-108	100-Series SST
241-S-109	100-Series SST
241-S-110	100-Series SST
241-S-111	100-Series SST
241-S-112	100-Series SST

Table H.1. In-Use Facilities (Page 3 of 7)

A. Single-Shell Tank Facilities (Continued)

Facility Number	Description
241-SX-101	100-Series SST
241-SX-102	100-Series SST
241-SX-103	100 Series SST
241-SX-104	100-Series SST
241-SX-105	100-Series SST
241-SX-106	100-Series SST
241-SX-107	100-Series SST
241-SX-108	100-Series SST
241-SX-109	100-Series SST
241-SX-110	100-Series SST
241-SX-111	100-Series SST
241-SX-112	100-Series SST
241-SX-113	100-Series SST
241-SX-114	100-Series SST
241-SX-115	100-Series SST
241-T-101	100-Series SST
241-T-102	100-Series SST
241-T-103	100-Series SST
241-T-104	100-Series SST
241-T-105	100-Series SST
241-T-106	100-Series SST
241-T-107	100-Series SST
241-T-108	100-Series SST
241-T-109	100-Series SST
241-T-110	100-Series SST
241-T-111	100-Series SST
241-T-112	100-Series SST
241-T-201	200-Series SST
241-T-202	200-Series SST
241-T-203	200-Series SST
241-T-204	200-Series SST
241-TX-101	100-Series SST
241-TX-102	100-Series SST
241-TX-103	100-Series SST
241-TX-104	100-Series SST
241-TX-105	100-Series SST
241-TX-106	100-Series SST
241-TX-107	100-Series SST
241-TX-108	100-Series SST
241-TX-109	100-Series SST
241-TX-110	100-Series SST
241-TX-111	100-Series SST

Table H.1. In-Use Facilities (Page 4 of 7)

A. Single-Shell Tank Facilities (Continued)

Facility Number	Description
241-TX-112	100-Series SST
241-TX-113	100-Series SST
241-TX-114	100-Series SST
241-TX-115	100-Series SST
241-TX-116	100-Series SST
241-TX-117	100-Series SST
241-TX-118	100-Series SST
241-TY-101	100-Series SST
241-TY-102	100-Series SST
241-TY-103	100-Series SST
241-TY-104	100-Series SST
241-TY-105	100-Series SST
241-TY-106	100-Series SST
241-U-101	100-Series SST
241-U-102	100-Series SST
241-U-103	100-Series SST
241-U-104	100-Series SST
241-U-105	100-Series SST
241-U-106	100-Series SST
241-U-107	100-Series SST
241-U-108	100-Series SST
241-U-109	100-Series SST
241-U-110	100-Series SST
241-U-111	100-Series SST
241-U-112	100-Series SST
241-U-201	200-Series SST
241-U-202	200-Series SST
241-U-203	200-Series SST
241-U-204	200-Series SST

B. Waste Transfer Vaults (None)

C. Miscellaneous Tanks (None)

Table H.1. In-Use Facilities (Page 5 of 7)

D. Diversion Boxes

Facility Number	Description
241-AX-155	Diversion Box
241-AR-151	Diversion Box

E. Valve Pits

Facility Number	Description
241-A-A	Valve Pit
241-A-B	Valve Pit
241-AX-A	Valve Pit
241-AX-B	Valve Pit
241-S-A	Valve Pit
241-S-B	Valve Pit
241-S-C	Valve Pit
241-S-D	Valve Pit
241-SX-A	Valve Pit
241-SX-B	Valve Pit
241-U-A	Valve Pit
241-U-B	Valve Pit
241-U-C	Valve Pit
241-U-D	Valve Pit

Table H.1. In-Use Facilities (Page 6 of 7)

F. Single-Shell Tank Pits

Facility Number	Description
241-A-01H	Distributor Pit
241-AX-01A	Pump Pit
241-BY-05A	Pump Pit
241-BY-06A	Pump Pit
241-C-02B	Heel Pit
241-C-03B	Heel Pit
241-C-04A	Pump Pit
241-C-04B	Heel Pit
241-C-04C	Sluice Pit
241-C-04D	Salt Well Caisson
241-C-06A	Pump Pit
241-C-06B	Heel Pit
241-C-06C	
241-S-01A	Pump Pit
241-S-02B	Distributor Pit
241-S-07A	Pump Pit
241-S-09A	Pump Pit
241-S-11A	Pump Pit
241-S-12A	Pump Pit
241-SX-01A	Pump Pit
241-SX-02B	Pump Pit
241-SX-03B	Pump Pit
241-SX-05A	Pump Pit
241-U-02B	Distributor Pit
241-U-07B	Distributor Pit
241-U-08B	Distributor Pit
241-U-09A	Pump Pit
241-U-09B	Distributor Pit
241-U-11A	Pump Pit

Table H.1. In-Use Facilities (Page 7 of 7)

G. Flush Pits (None)

H. Miscellaneous Structures (None)

I. Transfer Lines

Line Number	Connecting Facility	Connecting Facility
SL100	241-AX-B	241-A-B-R3
SL103	241-U-B-R3	241-U-D-R10
SL104	241-A-B	241-A-A
SL107	241-A-01H	241-A-A-L5
SL108	241-AX-01A	241-AX-A-L9
SL110	241-AX-A	241-AX-B
SL111	241-U-02B	241-U-B
SL113	241-U-C	241-U-D
SL114	241-U-B	241-U-A
SL138	242-S	SL-175
SL175	SL-138	241-SY-A -R2
SL140	241-S-102	241-S-A
SN204	241-U-09A	241-U-C
SN216/SN282	241-U-D-R1	241-SY-B-L3
SN275	241-SY-A-L1	241-S-A-L20
SN276	241-SY-B-R1	241-S-B-R20
V517	202-S	241-S-151
V720	241-AR Vault	

Table H.2. Inactive/Not In-Use Facilities (Page 1 of 41)

A. Single-Shell Tanks (None)

B. Waste Transfer Vaults

Facility Number	Description
244-BXR Vault	Vault contains four tanks (244-BXR-001 thru -003 plus 244-BXR-011)
244-TXR Vault	Vault contains three tanks (244-TXR-001 thru -003)
244-UR Vault	Vault contains four tanks (244-UR-001 thru -004)
244-AR Vault	Vault contains four tanks (244-AR-001 thru -004)
244-CR Vault	Vault contains four tanks (244-CR-001 thru -003 plus 244-CR-011)
231-W-151 Vault	Vault

C. Miscellaneous Tanks

Facility Number	Description
241-A-302A	Catch Tank
241-A-302B	Catch Tank
241-AX-151-CT	Catch Tank
241-B-301B (aka 241-B-301)	Catch Tank
241-B-302B	Catch Tank
241-BX-302A	Catch Tank
241-BX-302B	Catch Tank
241-BX-302C	Catch Tank
216-BY-201 (aka 241-BY; aka 216-BY-47)	Settling Tank
241-BY-ITS2-Tank 2	Catch Tank
241-C-301 (aka 241-C-301C)	Catch Tank
241-ER-311A	Catch Tank
240-S-302	Catch Tank
241-S-302B	Catch Tank

Table H.2. Inactive/Not In-Use Facilities (Page 2 of 41)

C. Miscellaneous Tanks (Continued)

Facility Number	Description
241-SX-302 (aka 241-SX-304)	Catch Tank
241-T-301B (aka 241-T-301)	Catch Tank
242-T-135	Storage Tank
242-TA-R1	Receiver Tank
241-TX-302A	Catch Tank
241-TX-302B	Catch Tank
241-TX-302BR	Catch Tank
241-TX-302XB (aka 241-TX-302X)	Catch Tank
241-TY-302A	Catch Tank
241-TY-302B	Catch Tank
200-W-7 (aka 243-S-Tk-1; aka 246-L)	Catch Tank
241-UX-702A	Miscellaneous Tank
231-W-151-001	Receiver Tank
231-W-151-002	Receiver Tank
241-Z-8	Settling Tank

Table H.2. Inactive/Not In-Use Facilities (Page 3 of 41)

D. Diversion Boxes

Facility Number	Description
241-A-151	200-PO-2 Operable Unit
241-A-152	Diversion Box
241-A-153	Diversion Box
241-AX-151	Diversion Box
241-AX-152	Diversion Box
241-AX-153	Diversion Box
241-B-151	Diversion Box
241-B-152	Diversion Box
241-B-153	Diversion Box
241-B-154	Diversion Box
241-B-252	Diversion Box
242-B-151	Diversion Box
241-BR-152	Diversion Box
241-BX-153	Diversion Box
241-BX-154	Diversion Box
241-BX-155	Diversion Box
241-BXR-151	Diversion Box
241-BXR-152	Diversion Box
241-BXR-153	Diversion Box
241-BYR-152	Diversion Box
241-BYR-153	Diversion Box
241-BYR-154	Diversion Box
241-C-151	Diversion Box
241-C-152	Diversion Box
241-C-153	Diversion Box

Table H.2. Inactive/Not In-Use Facilities (Page 4 of 41)

D. Diversion Boxes (Continued)

Facility Number	Description
241-C-154	Diversion Box
241-C-252	Diversion Box
241-CR-151	Diversion Box
241-CR-152	Diversion Box
241-CR-153	Diversion Box
241-ER-152	Diversion Box
240-S-151	Diversion Box
240-S-152	Diversion Box
241-S-152	Diversion Box
241-SX-151	Diversion Box
241-SX-152	Diversion Box
241-T-151	Diversion Box
241-T-152	Diversion Box
241-T-153	Diversion Box
241-T-252	Diversion Box
242-T-151	Diversion Box
241-TR-152	Diversion Box
241-TR-153	Diversion Box
241-TX-153	Diversion Box
241-TX-155	Diversion Box
241-TXR-151	Diversion Box
241-TXR-152	Diversion Box
241-TXR-153	Diversion Box
241-TXR-244	Diversion Box
241-TY-153	Diversion Box
241-U-153	Diversion Box
241-U-252	Diversion Box

Table H.2. Inactive/Not In-Use Facilities (Page 5 of 41)

D. Diversion Boxes (Continued)

Facility Number	Description
241-UR-151	Diversion Box
241-UR-152	Diversion Box
241-UR-153	Diversion Box
241-UR-154	Diversion Box
241-UR-244	Diversion Box

E. Valve Pits

Facility Number	Description
241-BY-109	Valve Pit
241-C	Valve Pit
241-WS-3	209-E-WS-3 Critical mass laboratory Valve Pit

F. Single-Shell Tank Pits

Facility Number	Description
241-A-01A	Pump Pit
241-A-01B	Pump Pit
241-A-01C	Sluice Pit
241-A-02A	Pump Pit
241-A-02B	Pump Pit
241-A-02C	Receiving Pit
241-A-02D	Distribution Pit
241-A-03A	Pump Pit
241-A-03B	Pump Pit
241-A-03C	Pump Pit
241-A-03D	Distribution Pit
241-A-04A	Pump Pit
241-A-04B	Sluice Pit
241-A-04C	Sluice Pit
241-A-05A	Pump Pit
241-A-05B	Sluice Pit
241-A-05C	Pump Pit
241-A-05D	Sluice Pit
241-A-06A	Pump Pit
241-A-06B	Sluice Pit
241-A-06C	Pump Pit
241-A-06D	Distribution Pit

Table H.2. Inactive/Not In-Use Facilities (Page 6 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-AX-01B	Pump Pit
241-AX-01C	Sluice Pit
241-AX-01D	Sluice Pit
241-AX-02A	Distribution Pit
241-AX-02B	Pump Pit
241-AX-02C	Sluice Pit
241-AX-02D	Pump Pit
241-AX-03A	Distribution Pit
241-AX-03B	Pump Pit
241-AX-03C	Sluice Pit
241-AX-03D	Pump Pit
241-AX-04A	Distribution Pit
241-AX-04B	Pump Pit
241-AX-04C	Sluice Pit
241-AX-04D	Sluice Pit
241-B-01A	Pump Pit
241-B-01B	Heel Pit
241-B-01C	Sluice Pit
241-B-02A	Pump Pit
241-B-02B	Heel Pit
241-B-02C	Sluice Pit
241-B-03A	Pump Pit
241-B-03B	Heel Pit
241-B-03C	Sluice Pit
241-B-06A	Pump Pit
241-B-08A	Pump Pit
241-B-09A	Pump Pit
241-B-112A	Pump Pit
241-B-04	No pit, covered saltwell caisson
241-B-05	No pit, covered saltwell caisson
241-B-07	No pit, covered saltwell caisson
241-B-104	Pump Pit
241-B-105	Pump Pit
241-B-107	Pump Pit
241-B-109	Pump Pit
241-B-110	No pit, covered saltwell caisson
241-B-111	No pit, covered saltwell caisson
241-B-201	Condenser Vent
241-B-202	Condenser Vent
241-B-203	Condenser Vent
241-B-204	Condenser Vent

Table H.2. Inactive/Not In-Use Facilities (Page 7 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-BX-01A	Pump Pit
241-BX-01B	Heel Pit
241-BX-01C	Sluice Pit
241-BX-02A	Pump Pit
241-BX-02B	Heel Pit
241-BX-02C	Sluice Pit
241-BX-03A	Pump Pit
241-BX-03B	Heel Pit
241-BX-03C	Sluice Pit
241-BX-04A	Pump Pit
241-BX-04B	Heel Pit
241-BX-04C	Sluice Pit
241-BX-05A	Pump Pit
241-BX-05B	Heel Pit
241-BX-05C	Sluice Pit
241-BX-06A	Pump Pit
241-BX-06B	Heel Pit
241-BX-06C	Sluice Pit
241-BX-08A	Pump Pit
241-BX-110A	Pump Pit
241-BX-111A	Pump Pit
241-BX-112A	Pump Pit
241-BX-07	No pit, covered saltwell caisson
241-BX-09	No pit, covered saltwell caisson
241-BX-107	Pump Pit
241-BX-109	Pump Pit
241-BY-01A	Pump Pit
241-BY-01C	Sluice Pit
241-BY-01D	Sluice Pit
241-BY-02A	Pump Pit
241-BY-02B	Heel Pit
241-BY-02C	Sluice Pit
241-BY-02D	Sluice Pit
241-BY-03A	Pump Pit
241-BY-03C	Sluice Pit
241-BY-03D	Sluice Pit
241-BY-04A	Pump Pit
241-BY-04C	Sluice Pit
241-BY-04D	Sluice Pit
241-BY-05C	Sluice Pit
241-BY-05D	Sluice Pit
241-BY-06C	Sluice Pit

Table H.2. Inactive/Not In-Use Facilities (Page 8 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-BY-06D	Sluice Pit
241-BY-07A	Pump Pit
241-BY-08A	Pump Pit
241-BY-09A	Pump Pit
241-BY-110A	Pump Pit
241-BY-111A	Pump Pit
241-BY-111B	Heel Pit
241-BY-111C	Sluice Pit
241-BY-111D	Sluice Pit
241-BY-112A	Pump Pit
241-BY-112C	Sluice Pit
241-BY-112D	Sluice Pit
241-C-07	No pit, covered saltwell caisson
241-C-08	No pit, covered saltwell caisson
241-C-09	No pit, covered saltwell caisson
241-C-110	No pit, covered saltwell caisson
241-C-111	No pit, covered saltwell caisson
241-C-112	No pit, covered saltwell caisson
241-C-01A	Pump Pit
241-C-01B	Heel Pit
241-C-01C	Sluice Pit
241-C-02A	Pump Pit
241-C-02C	Sluice Pit
241-C-03A	Pump Pit
241-C-03C	Sluice Pit
241-C-05A	Pump Pit
241-C-05B	Heel Pit
241-C-05C	Sluice Pit
241-S-02A	Pump Pit
241-S-03A	Pump Pit
241-S-04A	Pump Pit
241-S-05A	Pump Pit
241-S-06A	Pump Pit
241-S-08A	Pump Pit
241-SX-03A	Pump Pit
241-SX-04A	Pump Pit
241-SX-05B	Heel Pit
241-SX-06A	Pump Pit
241-SX-07A	Pump Pit
241-SX-08A	Pump Pit
241-SX-09A	Pump Pit

Table H.2. Inactive/Not In-Use Facilities (Page 9 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-SX-10A	Pump Pit
241-SX-11A	Pump Pit
241-SX-12A	Pump Pit
241-SX-13A	Pump Pit
241-SX-14A	Pump Pit
241-SX-15A	Pump Pit
241-T-01A	Pump Pit
241-T-01B	Heel Pit
241-T-01C	Sluice Pit
241-T-02A	Pump Pit
241-T-02B	Heel Pit
241-T-02C	Sluice Pit
241-T-03A	Pump Pit
241-T-03B	Heel Pit
241-T-04	No pit, covered saltwell caisson
241-T-05	No pit, covered saltwell caisson
241-T-06	No Pit, covered saltwell caisson
241-T-07	No Pit, covered saltwell caisson
241-T-08	No Pit, covered saltwell caisson
241-T-09	No Pit, covered saltwell caisson
241-T-111	No pit, covered saltwell caisson
241-T-112	No Pit, covered saltwell caisson
241-T-201	No Pit, covered saltwell caisson
241-T-202	No Pit, covered saltwell caisson
241-T-203	No Pit, covered saltwell caisson
241-T-204	No Pit, covered saltwell caisson
241-TX-01A	Pump Pit
241-TX-01C	Sluice Pit
241-TX-01D	Sluice Pit
241-TX-02A	Pump Pit
241-TX-02C	Sluice Pit
241-TX-02D	Sluice Pit
241-TX-03A	Pump Pit
241-TX-03C	Sluice Pit
241-TX-03D	Sluice Pit
241-TX-04A	Pump Pit
241-TX-04C	Sluice Pit
241-TX-04D	Sluice Pit
241-TX-05A	Pump Pit
241-TX-05C	Sluice Pit
241-TX-05D	Sluice Pit

Table H.2. Inactive/Not In-Use Facilities (Page 10 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-TX-06A	Pump Pit
241-TX-06C	Sluice Pit
241-TX-06D	Sluice Pit
241-TX-07A	Pump Pit
241-TX-07C	Sluice Pit
241-TX-07D	Sluice Pit
241-TX-08A	Pump Pit
241-TX-08C	Sluice Pit
241-TX-08D	Sluice Pit
241-TX-09A	Pump Pit
241-TX-10A	Pump Pit
241-TX-11A	Pump Pit
241-TX-12A	Pump Pit
241-TX-13A	Pump Pit
241-TX-14A	Pump Pit
241-TX-15A	Sluice Pit
241-TX-15B	Pump Pit
241-TX-16A	Pump Pit
241-TX-17A	Pump Pit
241-TX-18A	Pump Pit
241-TY-01A	Pump Pit
241-TY-02A	Pump Pit
241-TY-03A	Pump Pit
241-TY-04A	Pump Pit
241-TY-05	No pit, covered saltwell caisson
241-TY-06	No pit, covered saltwell caisson
241-U-01A	Pump Pit
241-U-01B	Heel Pit
241-U-01C	Sluice Pit
241-U-02A	Pump Pit
241-U-03A	Pump Pit
241-U-03B	Heel Pit
241-U-03C	Sluice Pit
241-U-04A	Pump Pit
241-U-04B	Heel Pit
241-U-04C	Sluice Pit
241-U-05A	Pump Pit
241-U-05B	Heel Pit
241-U-05C	Sluice Pit
241-U-06A	Pump Pit
241-U-06B	Heel Pit

Table H.2. Inactive/Not In-Use Facilities (Page 11 of 41)

F. Single-Shell Tank Pits (Continued)

Facility Number	Description
241-U-06C	Sluice Pit
241-U-07A	Pump Pit
241-U-07C	Sluice Pit
241-U-08A	Pump Pit
241-U-08C	Sluice Pit
241-U-09C	Sluice Pit
241-U-10A	Pump Pit
241-U-10B	Distributor Pit
241-U-11B	Distributor Pit
241-U-12	No pit, covered saltwell caisson
241-U-201	No pit
241-U-202	No Pit
241-U-203	No Pit
241-U-204	No Pit

G. Flush Pits

Facility Number	Description
241-WR	Flush Pit

H. Miscellaneous Structures

Facility Number	Description
241-A-431	Ventilation Building
241-C-801	Cesium Loadout Facility
241-SX-401	Condenser Shielding Building
241-SX-402	Condenser Shielding Building
242-S	Evaporator
242-T	Evaporator
241-AX-IX	Ion Exchange Unit
241-BY-ITS1	In-Tank Solidification Unit

Table H.2. Inactive/Not In-Use Facilities (Page 12 of 41)

I. Transfer Lines

Line Number	Connecting Facility	Connecting Facility
103	241-SX-103-03-A	Capped
105	241-SX-105	241-SX-152
107	241-SX-107-07A-1	241-SX-152
108	241-SX-108-08A-1	241-SX-152
109	241-SX-109-09A-1	241-SX-152
110	241-SX-110-10A-1	241-SX-152
111	241-SX-111-11A-1	241-SX-152
112	241-SX-112-12A-1	241-SX-152
113	241-SX-113-13A-1	241-SX-152
114	241-SX-114-14A-1	241-SX-152
115	241-SX-115-15A-1	241-SX-152
234	241-S-102-02A-A	Unknown
235	241-S-102-02A-AA	Unknown
312	241-SX-102	Clean Out Boxes-15 Thru 22
318	241-SX-102	241-SX-A, SX-B Flush Pit
456	241-SX-152	Capped
540	241-S-107-07A	241-S-151-L18
703	241-TX-109-09A-A	241-T-151-U3
704	SN-249	241-TX-109-09A-D
704	SN-249	241-TY-103-A
704	SN-249	241-TY-102
704	SN-249	241-TY-105
706	241-TX-105-05A-C	704
707	241-TX-06A-A	241-TX-02A-C
708	241-TX-102-02A-D	241-TX-103-03A-A
709	241-TX-103-03A-C	241-TX-104-04A-A
710	241-TX-108-08A-A	241-TX-104-04A-C
711	241-TX-107-07A-A	241-TX-108-08A-C
714	241-TX-110-10A-C	241-TX-111-11A-A
715	241-TX-111-11A-C	241-TX-112-12A-A
717	241-TX-118	241-TX-112-012A-C/15B Valve Pit
718	241-TX-113-13A	241-TX-115
720	241-TX-114	241-15B Valve Pit
721	241-TX-114-14A	241-TX-115
723	241-TX-118-18A	242-T
724	241-TX-111	241-TX-14B Valve Pit
724	241-TX-118	242-T
724	241-TY-101-01A-A	241-TY-103-03A-A
726	241-TY-01A-C	241-TY-102-02A-A
727	241-TY-102-02A-C	241-TY-104-04A-C

Table H.2. Inactive/Not In-Use Facilities (Page 13 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
728	241-TX-118	241-TY-104-04A-C
730	241-TX-110	241-TX-14B Valve Pit
731	241-TX-117-17A	241-TX-118
750	241-TX-118-18A	241-TX-TX-115-15A-U2
800	241-BY-112-012D-U6	241-BY-111-011D-U6
801	241-BY-112-012D-U7	241-BY-111-011D-U7
801	244-AR-T-6	241-A-153-A
804	241-BY-110-010-A	241-BY-111-A
805	241-BY-107-07A-A	241-BY-110-010A-C
805	244-AR-T-13	241-A-153-B
806	241-BY-102-02A-U8	241-BY-111-011D-U4
806	241-BY-104-04D-A	241-BY-107-07A-D
807	241-BY-105-05D-A	241-BY-104-04D-C
808	241-BY-102	241-BY-105-05D-D
809	241-BY-103-03C-A	241-BY-105-05D-C
810	241-BY-103-03C-C	241-BY-106-06D-A
813	241-BY-108-08A-A	241-BY-107-07A-C
814	241-BY-102-02B	241-BY-111-011D-U8
814/4002/4028/G026/4001/T031	244-AR Vault-TK-001	PUREX
815	241-BY-110-010A-D	241-BX-112-012-A-A
816	241-BX-112-012A-C	241-BX-111-011A-A
817	241-BX-111-011A-C	241-BX-110-010A-A
819	244-AR-Tank-001-T5	244-AR-Tank-003-T14
820	241-BX-106-06A-C	241-BX-105-05A-A
820	Encasement Drain for V-383, V-384, V-385 from 241-TX-154	241-TX-152-U5
821	241-BY-101-01C-A	241-BX-105-05A-C
822	241-BX-105-05A	241-B-109-09A-C
822	241-BY-101-01C-C	241-BY-104-04D
823	241-BX-105-05A-E	241-B-112-012A-A
824	241-B-112-012A-C	241-B-108-08A-A
826	241-B-109-09A-D	241-B-108-08A-D
827	241-B-103-03A-UA	241-B-102-02A-U4
829	241-B-106-06A-C	241-B-109-09A-A
837	244-AR-Tank-001-2,-3,-4	244-AR-Tank 001, 002, 003, 004
1006	205-S	240-S-152-U2
1045	240-S-152-U1	204-S
1115	240-S-151-U6	202-S
1140	240-S-151-U15	202-S
1145	240-S-151-U9	202-S
1238	202-S	240-S-151-U10
1540	240-S-151-U14	202-S

Table H.2. Inactive/Not In-Use Facilities (Page 14 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
1541	240-S-151-U5	202-S
3130	240-S-151-U1	202-S
3591	240-S-151-U18	202-S
3592	240-S-151-U19	202-S
3603	240-S-151-U7	Capped
3610	240-S-151-U16	202-S
3635	240-S-151-U11	202-S
3658	240-S-151-U4	202-S
3666	240-S-151-U2	202-S
4001/T029	PUREX	241-A-B-R12
4002	241-AX-151	None Identified
4002/T031/G026/402A	PUREX	244-AR
4003	241-AX-151	None Identified
4003/T037/4017	PUREX	241-AX-152
4004	241-AX-151	Capped
4004/G341/V029	PUREX	241-A-A-L12
4006	241-AX-151	Capped
4007	244-AR Vault-T8A	241-AX-151
4009	241-AX-151	None Identified
4010	241-AX-151-Catch Tank	241-AX-151-F-Cell
4011	241-AX-151-Catch Tank	241-AX-151-E-Cell
4012	241-CR-153	241-AX-151 D-Cell
4013	241-AX-151-D-Cell	241-CR-152-U3A
4014	241-AX-151	Capped
4016	241-AX-151-Catch Tank Pit	241-AX-151-E-Cell
4017	241-AX-151-Washdown	Capped
4018	241-AX-151-Washdown	Capped
4019	241-AX-151	Capped
4020	241-AX-151	Capped
4021	241-AY-151-Nozzle 3	241-AX-152-L2
4021	241-AY-151	Jumper Box 153-AX
4022	241-AX-151-D-CELL	241-AX-152 Pump Pit
4024	241-AX-152-B	Capped
4026	Jumper Box 153-AX-1	241-AX-101-01A-2
4026	Jumper Box 153-AX-1	241-AX-102-02A-2
4026	Jumper Box 153-AX-1	241-AX-103-03A-2
4026	Jumper Box 153-AX-1	241-AX-104-04A-2
4026	241-AX-101-01A-2	Leak Detection Pits-01E, 02E, 03E, 04E
4026	241-AX-152	Jumper Box 153-AX-2

Table H.2. Inactive/Not In-Use Facilities (Page 15 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
4030	241-AX-152	241-AX-152-B
4044/V029/4004/G341/4029	202A	241-A-B-VPL12
4101	241-AX-151	241-A-101
4102	241-AX-151	241-A-102
4103	241-AX-151	241-A-103
4104	241-AX-151	241-A-104
4105	241-AX-151	241-A-105
4106	241-AX-151	241-A-106
4242	240-S-151-U13	202-S
4530	241-AY-151-U4	241-A-153-U1
4702	241-UX-154-L-6	231-WR-TK-004
4703/4859	241-UX-154-L5	241-TX-155-U2
4851	241-UX-154-L-4	241-TX-155-U3
4878	241-UX-154-L-2	241-WR-TK-002
4977	241-UX-152-U4	241-WR-TK-001
5002	241-U-103-03A-U1	241-UR-152-L13
5006	241-U-102-02A-U1	241-UR-152-L12
5012	241-UR-152-U9,11,12	241-UR-151-U9
5014	241-U-103-03C-U1	241-UR-152-L10
5025	241-UR-152-U10	241-UR-151-U17
5032	241-U-103-03A-U2	241-UR-152-U6
5035	241-U-103-03C-U2	241-UR-152-U5
5037	241-U-102-02A-U3	241-UR-152-L15
5038	241-U-102-02A-U2	241-UR-152-U4
5041	241-U-102-02C-U2	241-UR-152-U3
5053	241-U-102-02C-U1	241-UR-152 Drain
5076	241-UR-Tank-001	U-103, 109,108,105,107,102
5185	241-TX-15A-U3	241-TXR-151-U11
5185	242-T-151-U2	242-T
5191	241-TX-115-15A-U1	15-X
5193	241-TX-115-15A-U6	15-B Valve Pit
5202	251-U-106-06A-U1	241-UR-153-L13
5206	241-U-105-05A-U1	241-UR-153-L12
5212	241-UR-153-U-9, 11,12	241-UR-151-U8
5214	241-U-106-06C-U1	241-UR-153-L10
5225	241-UR-151-U16	241-UR-153-U10
5232	241-U-106-06A-U2	241-UR-153-U6
5235	241-U-106-06C-U2	241-UR-153-U5
5237	241-U-105-05A-U3	241-UR-153-L15
5238	241-U-105-05A-U2	241-UR-153-U4
5241	241-U-105-05C-U2	241-UR-153-U3
5402	241-U-109-09A-U1	241-UR-154-L13
5406	241-U-108-08A-U1	241-UR-154-L12

Table H.2. Inactive/Not In-Use Facilities (Page 16 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
5410	241-U-107-07A-U1	251-UR-154-L11
5412	241-UR-151-U6	241-UR-154-U9,11,12
5414	241-U-109-09C-U1	241-UR-154-L10
5417	241-U-108-08C-U1	241-UR-154-L7
5420	241-U-107-07C-U1	241-UR-154-L9
5425	241-UR-151-U15	241-UR-154-U10
5431	241-U-107-07A-U3	241-UR-154-L14
5432	241-U-109-09A-U2	241-UR-154-U6
5435	241-U-109-09C-U2	241-UR-154-U5
5437	241-U-108-08A-U3	241-UR-154-L15
5438	241-U-108-08A-U2	241-UR-154-U4
5441	241-U-108-08C-U2	241-UR-154-U3
5444	241-U-107-07A-U2	241-U-154-U2
5447	241-U-107-07C-U2	241-U-UR-154-1
5507	241-UR-154-L8	241-U-153-L8
5601	244-UR-Tank-001	241-U4-151-L5
5609	244-UR-Tank-002-U2	251-U4-151-L3
5613	244-UR-Tank-001-U2	241-UR-151-L1
5622	244-UR-Tank-001-U3	241-UR-151-L7
5624	241-UR-152-L8	241-UR-151-U12
5625	241-UR-153-U8	241-UR-151-U11
5626	241-UR-151-U7	241-UR-154-U8
5630	241-UR-152-L1,2,3,4,5,6	241-UR-151-U14
5631	241-UR-153-L1,2,3,4,5,6	241-UR-151-U13
5632	241-UR-151-U10	241-UR-154-L1,2,3,4,5,6
5644	241-UR-151-U-18,19,21	241-UR-151-U-18,19,21
5647	244-UR-U1-Tank-001	241-UR-151-L8
5648	244-UR-U1-Tank-002	241-UR-151-L10
5653	244-UR-Tank-004	241-U4-151-L4
6002	241-T-103-03A-U1	241-TR-152-L13
6006	241-T-102-02A-U1	241-TR-152-L12
6010	241-T-101-01A-U1	241-TR-152-L11
6012	241-TR-153-U13	Capped
6012	241-TXR-151-U10	Capped
6012	241-T-104	244-TX-H
6014	241-T-103-03C-U1	241-TR-152-L10
6017	241-T-102-02C-U1	241-TR-152-L7
6020	241-T-101-01C-U1	241-TR-152-U2
6025	241-TXR-151-U20	241-TR-152-U10
6031	241-T-101-01A-U3	241-TR-152-L14
6032	241-T-103-03A-U2	241-TR-152-U6
6035	241-T-103-03C-U2	241-TR-152-U5

Table H.2. Inactive/Not In-Use Facilities (Page 17 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
6037	241-T-02A-U3	241-TR-152-L15
6038	241-T-102-02A-U2	241-TR-152-U4
6041	241-T-102-02C-U2	241-TR-152-U3
6044	241-T-101-01A-U2	241-TR-152-U2
6047	241-T-101-01C-U2	241-TR-152-U1
6053	241-T-101-01C	241-TR-152 Drain
6160	241-TR-152-U9, 11,12	241-TR-153-U2
6165	241-TR-153-U6	241-TR-152-L1, 2,3,4,5,6
6170	241-TR-152-U8	241-TR-153-U1
6202	241-BY-103-03A-U1	241-BYR-152-L13
6206	241-BY-102-02A-U1	241-BYR-152-L12
6210	241-BY-101-01A-U1	241-BYR-152-L11
6214	241-BY-103-03C-U1	241-BYR-152-L10
6217	241-BY-102-02C-U1	241-BYR-152-L7
6220	241-BY-101-01C-U1	241-BYR-152-L9
6232	241-BY-103-03D-U2	241-BYR-152-U6
6235	241-BY-103-03C-U2	241-BYR-152-U5
6238	241-BY-102-02D-U2	241-BYR-152-U4
6241	241-BY-102-02C-U2	241-BYR-152-U3
6244	241-BY-101-01D-U2	241-BYR-152-U2
6247	241-BY-101-01C-U2	241-BYR-152-U1
6249	241-BYR-152-U14	241-BXR-152-U13
6253	241-BYR-152/241-BXR-152	241-B-302A
6402	241-BYR-153-L13	241-BY-106-06A-U1
6406	241-BYR-153-L12	241-BY-105-05A-U1
6410	241-BYR-153-L11	241-BY-104-04A-U1
6414	241-BYR-153-L10	241-BY-106-06C-U1
6417	241-BYR-153-L7	241-BY-105-05C-U1
6420	241-BYR-153-L9	241-BY-104-04C-U1
6432	241-BYR-153-U6	241-BY-106-06D-U2
6435	241-BYR-153-U5	241-BY-106-06C-U2
6438	241-BYR-153-U4	241-BY-105-05D-U2
6441	241-BYR-153-U3	241-BY-105-05C-U2
6444	241-BYR-153-U2	241-BY-104-04D-U2
6447	241-BYR-153-U1	241-BY-104-04C-U2
6449	241-BYR-153-U14	241-BXR-153-U13
7002	241-TX-103-03A-U1	241-TXR-152-L16
7006	241-TX-102-02A-U1	241-TXR-152-L15
7010	241-TX-101-01A-U1	241-TXR-152-L14
7012	241-TXR-152-U10, 12,13	241-TXR-151-U8
7014	241-TX-103-03C-U1	241-TXR-152-L13
7017	241-TX-102-02C-U1	241-TXR-152-L9

Table H.2. Inactive/Not In-Use Facilities (Page 18 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
7020	241-TX-101-01C-U1	241-TXR-152-L12
7025	241-TXR-152-U11	241-TXR-151-U19
7031	241-TX-101-01D-U1	241-TR-152-L18
7032	241-TX-103-03D-U2	241-TXR-152-U6
7035	241-TX-103-03C-U2	241-TXR-152-U5
7037	241-TX-102-02D-U1	241-TSR-152-L19
7038	241-TX-102-02D-U2	241-TXR-152-U4
7041	241-TX-102-02C-U2	241-TXR-152-U3
7044	241-TX-101-01D-U2	241-TXR-152-U2
7047	241-TX-101-01C-U2	241-TXR-152-U1
7159	241-TX-104-04A-U1	241-TXR-152-L17
7162	241-TX-104-04C-U1	241-TXR-152-L11
7164	241-TX-104-04C-U2	241-TXR-152-U7
7166	241-TX-104-04D-U2	241-TXR-152-U8
7202	241-TX-107-07A-U1	241-TXR-153-L16
7206	241-TX-106-06A-U1	241-TXR-153-L15
7210	241-TX-105-05A-U1	241-TXR-153-L14
7212	241-TXR-151-U6	241-TXR-153-U10, 12, 13
7214	241-TX-107-07C-U1	241-TXR-153-L13
7217	241-TX-106-06C-U1	241-TXR-153-L9
7220	241-TX-105-05C-U1	241-TXR-153-L12
7225	241-TXR-151-U18	241-TXR-153-U11
7231	241-TX-105-05D-U1	241-TXR-153-L18
7232	241-TX-107-07D-U2	241-TXR-153-U6
7235	241-TX-107-07C-U2	241-TXR-153-U5
7237	241-TX-106-06D-U1	241-TXR-153-L19
7238	241-TX-106-06D-U2	241-TXR-153-U4
7241	241-TX-106-06C-U2	241-TXR-153-U3
7244	241-TX-105-05D-U2	241-TXR-153-U2
7247	241-TX-105-05C	241-TXR-153-U1
7359	241-TX-115-015A-U4	241-TXR-153-L17
7362	241-TX-108-08C-U1	241-TXR-153-L11
7364	241-TX-108-08C-U2	241-TXR-153-U7
7366	241-TX-108-08D-U2	241-TXR-153-U8
7410	241-BY-111-011A-U1	241-BYR-154-L11
7412	241-BYR-154-U9,11,12	241-BXR-151-U4
7417	241-BY-112-012C-U1	241-BYR-154-L10
7420	241-BY-111-011C-U1	241-BYR-154-L9
7425	241-BYR-154-U10	241-BXR-151-U20
7431	241-BY-111-011D-U1	241-BYR-154-L14
7437	241-BY-112-012D-U1	241-BYR-154-L15
7438	241-BY-112-012D-U2	241-BYR-154-U4

Table H.2. Inactive/Not In-Use Facilities (Page 19 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
7441	241-BY-112-012C-U2	241-BYR-154-U3
7444	241-BY-111-011D-U2	241-BYR-154-U2
7447	241-BY-111-011C-U2	241-BYR-154-U2
7601	241-TXR-244-Tank-001	241-TXR-151-L5
7609	241-TXR-151-L3	241-TXR-244 Tank002-U2
7613	241-TXR-244-U2-Tank-003	241-TXR-151-L1
7616	241-TX-155-L1	241-TXR-151-U2, U3
7622	241-TXR-244-U3-Tank-001	241-TXR-151-L7
7624	241-TR-153-U14	Capped
7624	241-TXR-151-U14	Capped
7625	241-TXR-151-U13	241-TXR-153-U9
7624	241-TR-153-U14	Capped
7624	241-TXR-151-U14	Capped
7626	241-TXR-152-U9	241-TXR-151-U7
7630	241-TXR-151-U17	241-TR-153-U9
7631	241-TXR-151-U15	241-TXR-153-L1, 2,3,4,5,6,7,8
7632	241-TXR-152-L1, 2,3,4,5,6,7,8	241-TXR-151-U12
7636	241-TXR-151-U5	241-TX-153-L5
7644	241-TXR-151-U21, 23, 25	241-TXR-151-U21, 23, 25
7647	241-TXR-244-U1-Tank-003	241-TXR-151-L8
7648	241-TXR-244-U1-Tank-002	241-TXR-151-L10
7765	244-UR Tank 002	241-UR-151 Drain
8002	241-C-103-03A-U1	241-CR-152-L13
8006	241-C-102-02A-U1	241-CR-152-L12
8010	241-C-101-01A-U1	241-CR-152-L11
8012	241-CR-152-U9, U11, U12	241-CR-151-U4
8014	241-C-103-03C-U1	241-CR-152-L10
8017	241-C-102-02C-U1	241-CR-152-L7
8020	241-C-101-01C-U1	241-CR-152-L9
8021	241-AY-152-U10	241-AX-103-03D-U3
8022	241-AY-152-U11	241-AX-103-03C-U5
8023	241-AY-152-U14	241-AX-102-02C-U3
8024	241-AY-152-U15	241-AX-102-02D-U5
8025	241-AY-152-U12	241-AX-101-01D-U3
8026	241-AY-152-U13	241-AX-101-01C-U5
8027	241-AY-152-U16	241-AX-104-04C-U3
8028	241-AY-152-U17	241-AX-104-04D-U5
8029	241-AX-103-03A-U4	241-AX-103-03C-U3
8030	241-AX-103-03B-U3	241-AX-103-03D-U5
8031	241-AX-103-03A-U9	241-AX-103-03B-U5
8031	241-C-101-01A-U3	241-CR-152-L14
8032	241-AX-104-04D-U3	241-AX-104-04B-U5
8032	241-C-103-03A-U2	241-CR-152-U6

Table H.2. Inactive/Not In-Use Facilities (Page 20 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
8033	241-AX-104-04A-U4	241-AX-104-04B-U3
8034	241-AX-104-04C-U5	241-AX-104-04A-U4A
8035	241-AX-102-02C-U4	241-AX-102-02A-U7
8035	241-C-103-03C-U2	241-CR-152-U5
8036	241-AX-102-02A-U4	241-AX-102-02B-U3
8037	241-AX-102-02B-U5	241-AX-102-02D-U3
8037	241-C-102-02A-U3	241-CR-152-L15
8038	241-AX-101-01AU4	241-AX-101-01C-U3
8038	241-C-102-02A-U2	241-CR-152-U4
8039	241-AX-101-01A-U9	241-AX-101-01B-U5
8040	241-AX-101-01B-U3	241-AX-101-01D-U5
8041	241-AX-101-01A-U6	241-AX-101-01C-U4
8041	241-C-102-02C-U2	241-CR-152-U3
8042	241-AX-102-02C-U5	241-AX-102-02A-U9
8043	241-AX-103-03A-U6	241-AX-103-03C-U4
8044	241-AX-104-04C-U4	241-AX-104-04A-U7
8044	241-C-101-01A-U2	241-CR-152-U2
8047	241-C-101-01C-U2	241-CR-152-U1
8061	241-AY-152-L7	241-AX-104-04A-U5
8062	241-AX-102-02A-U5	241-AY-152-L6
8063	241-AY-152-L5	241-AX-101-01A-U8
8064	241-AY-152-L4	241-AX-102/241-AX-103
8202	241-C-106-06A-U1	241-CR-153-L13
8206	241-C-105-05A-U1	241-CR-153-L12
8210	241-C-104-04A-U1	241-CR-153-L11
8214	241-C-106-06C-U1	241-CR-153-L10
8217	241-C-105-05C-U1	241-CR-153-L7
8220	241-C-104-04C-U1	241-CR-153-L9
8225	241-CR-153-U10	241-CR-151-U10
8231	241-C-104-04A-U3	241-CR-153-L14
8232	241-C-106-06A-U2	241-CR-153-U6
8235	241-C-106-06C-U2	241-CR-153-U5
8237	241-C-105-05A-U3	241-CR-153-L15
8238	241-C-105-05A-U2	241-CR-153-U4
8241	241-C-105-05C-U2	241-CR-153-U3
8244	241-C-104-04A-U2	241-CR-153-U2
8247	241-C-104-04C-U2	241-CR-153-U1
8552	241-C-201, 202,203,204-U2	241-CR-151-U2
8555	241-CR-151-U5	241-C-201,202, 203,204-U2
8601	241-CR-151-L1	244-CR-Tank-001
8616	241-CR-151-L5	244-CR-Tank-011-U1
8624	241-CR-152-U8	241-CR-151-U7
8625	241-CR-153-U8	241-CR-151-U6

Table H.2. Inactive/Not In-Use Facilities (Page 21 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
8630	241-CR-152-L1, 2,3,4,5,6	241-CR-151-U9
8631	241-CR-153-L (1-6)	241-CR-151-U8
8644	241-CR-151-U12, 13,15	241-CR-151-U12,U13,U15
8647	241-CR-151-L4	244-CR-Tank-003-U1
8648	241-CR-151-L6	244-CR-Tank-002-U1
8653/8618	241-ER-151-L9	241-CR-151-U14
8656	241-AX-151	244-CR DCRT Tank 003
8900	201-C Valve Box	244-CR-Tank-003-U10
9002	241-B-103-03A-U1/03B-U2	241-BR-152-L13
9006	241-B-102-02A-U1/02B-U2	241-BR-152-L12
9010	241-B-101-01A-U1/01B-U2	241-BR-152-L11
9012	241-BXR-151-U8	241-BR-152-U9
9014	241-B-103-03C-U1	241-BR-152-L10
9017	241-B-102-02C-U1	241-BR-152-L7
9020	241-B-101-01C-U1	241-BR-152-L9
9025	241-BXR-151-U19	241-BR-152-U10
9031	241-B-101-01A-U3	241-BR-152-L14
9032	241-B-103-03A-U2	241-BR-152-U6
9035	241-B-103-03C-U2	241-BR-152-U5
9037	241-B-102-02A-U3	241-BR-152-L15
9038	241-B-102-02A-U2	241-BR-152-U4
9041	241-B-102-02C-U2	241-BR-152-U3
9044	241-B-101-01A-U2	241-BR-152-U2
9047	241-B-101-01C-U2	241-BR-152-U1
9202	241-BX-103-03A-U1	241-BXR-152-L13
9206	241-BX-102-02A-U1	241-BXR-152-L12
9212	241-BYR-152-U9, U11,U12	241-BXR-151-U6
9212	241-BYR-152-U9, U11,U12	241-BXR-152-U9, U11,U12
9214	241-BX-103-03C-U2	241-BXR-152-L10
9217	241-BX-102-02C-U1	241-BXR-152-L7
9225	241-BYR-152-U10	241-BXR-151-U18
9225	241-BYR-152-U10	241-BXR-152-U10
9231	241-BX-101-01A-U3	241-BXR-152-L14
9232	241-BX-103-03A-U2	241-BXR-152-U6
9235	241-BX-103-03C-U1	241-BXR-152-U5
9237	241-BX-102-02A-U3	241-BXR-152-L15
9238	241-BX-102-02A-U2	241-BXR-152-U4
9241	241-BX-102-02C-U2	241-BXR-152-U3
9244	241-BX-101-01A-U2	241-BXR-152-U2
9247	241-BX-101-01C-U2	241-BXR-152-U1
9249	241-BYR-152-U13	241-BXR-152-U14
9256	241-BX-103-03B-U2	241-BX-103-03A-U1
9263	241-BX-102-02B-U2	241-BX-102-02A-U1

Table H.2. Inactive/Not In-Use Facilities (Page 22 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
9270	241-BX-101-01B-U2	241-BX-101-01A-U1
9412	241-BYR-153-U9,U11,U12	241-BXR-151-U3
9414	241-BX-106-06C-U1	241-BXR-153-L10
9417	241-BX-105-05C-U1	241-BXR-153-L7
9420	241-BX-104-04C-U1	241-BXR-153-L9
9425	241-BYR-153-U10	241-BXR-151-U17
9425	241-BYR-153-U10	241-BXR-153-U10
9431	241-BX-104-04A-U3	241-BXR-153-L14
9432	241-BX-106-06A-U2	241-BXR-153-U6
9435	241-BX-106-06C-U2	241-BXR-153-U5
9437	241-BX-105-05A-U3	241-BXR-153-L15
9438	241-BX-105-05A-U2	241-BXR-153-U4
9441	241-BX-105-05C-U2	241-BXR-153-U3
9444	241-BX-104-04A-U2	241-BXR-153-U2
9447	241-BX-104-04C-U2	241-BXR-153-U1
9449	241-BYR-153-U13	241-BXR-153-U14
9463	241-BX-105-05B-U2	9406/9463/241-BX-105-05A-U1
9465	241-BX-106-06B-U2	9402/9456/241-BX-106-06A-U1
9601	244-BXR-Tank-001	241-BXR-151-L1
9604	244-BXR-Tank-003	244-BXR Tank-O01-U2
9613	244-BXR-Tank-003-U2	244-BXR Tank 011
9616	244-BXR-011-U1	241-BXR-151-L5
9622	244-BXR-Tank-001-U3	241-BXR-151-L3
9623	241-BYR-154-U8	241-BXR-151-U15
9624	241-BXR-151-U12	241-BR-152-U8
9626	241-BYR-153-U8	241-BXR-151-U5
9626	241-BYR-153-U8	241-BXR-153-U8
9630	241-BXR-151-U15	241-BR-152-L1
9631	241-BXR-151-U13	241-BXR-152-L1,L2,L3,L4,L5,L6
9631	241-BXR-151-U13	241-BYR-152-L1,L2,L3,L4,L5,L6
9632	241-BXR-151-U10	241-BYR-151-L1,L2,L3,L4,L5,L6
9632	241-BXR-151-U10	241-BXR-153-L1,L2,L3,L4,L5,L6
9633	241-BYR-154-L1,L2,L3,L4,L5	241-BXR-151-U9
9636	241-BXR-151-U2	241-B-252-U8
9644	241-BXR-151-U21,U23,U25	241-BXR-151-U21,U23,U25
9647	244-BXR-Tank-003-U1	241-BXR-151-L4
9648	244-BXR-Tank-002-U1	241-BXR-151-L6
9719	241-BXR-151-U24	241-ER-151-L3
9765	241-BXR-151-Drain	244-BXR Vault
01A	241-A-101-01A-U7	241-A-153-U5
01B	241-A-101-01B-U1	241-A-153-L10
01C	241-A-101-01C-U1	241-A-153-L9

Table H.2. Inactive/Not In-Use Facilities (Page 23 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
02A	241-A-102-02A-U7	241-A-153-U4
02B	241-A-102-02B-U1	241-A-153-L11
03A	241-A-103-03A-U7	241-A-153-U6
03B	241-A-103-03B-U1	241-A-153-L12
03C	241-A-103-03C-U1	241-A-153-L7
04B	241-A-104-04B-U1	241-A-153-L4
04C	241-A-104-04C-U1	241-A-153-L3
05B	241-A-105-05B-U1	241-A-103-03A-U4
05B	241-A-105-05B-U1	241-A-153-L6
05C	241-A-105-05C-B	241-A-103-03D/241-A-153-U2
05D	241-A-105-05D-U1	241-A-153-L2
06A	241-A-106-06A-U7	241-A-153-U3
06B	241-A-106-06B-U1	241-A-153-L5
06C	241-A-106-06C-U1	241-A-153-L1
108/837/8649/8901	221-B	244-CR DCRT
153A	241-A-101	241-A-153-Drain
223/224/225/226	244-BX-Vault	241-B-106, 105,109
223/Unk	244-BX-Vault	241-B-103
Unk	241-A-102-02C-U1	241-A-153-L8
227/228	244-BX-Vault	241-B-108, 111
231/232/233/234	244-BX-Vault	241-B-104, 107,110
4044	241-AX-151-G Cell	Capped
4005/810	241-AX-151-D Cell	244-AR Vault-T9
4006	241-AX-151-E Cell	Capped
4006/4018	244-AR Vault-T9A	241-AX-152-A
4107VO33	241-AX-151-D Cell	241-A-152-U11
4510/A107	241-AX-152-7	Capped
4859/4703	241-TX-155-U2	241-UX-154-L5
5107	241-UR-152-L8	5107/V473/241-UR-153-L11
5307	241-UR-153-L8	5107/V473/241-UR-152-L11
5507	241-UR-154-L8	5107/V473/241-UR-152-L11
6307/V336	241-BYR-152-L8	241-BX-153-U2
6443/9453	241-BYR-153 & 241-BXR-153 Drains	241-BX-104-04C
7406/9394	241-BY-109-09A-U4	241-BYR-154-L12
7406/9394	241-BY-112-012A-U1	241-BY-109-09A-U4
7435/9385/V304	241-BYR-154-U5,L13	241-B-252-L15
7507/9712	241-BYR-154-L8	B-Swamp
814/4015	241-AX-151	Capped
819/818	241-BX-106-06A-U4	241-BX-110010C-C
833/8618/8612/809	221-B	244-AR Vault-T16A

Table H.2. Inactive/Not In-Use Facilities (Page 24 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
834/8615/8653/818	221-B	244-AR Vault-T10
8107	241-CR-152-L8	V844/241-CR-151-L8
8636/V105	241-CR-151-U1	241-C-151-L6
9210/9270	241-BX-101-01B-U2	241-BXR-152-L11
9406/9463	241-BX-105-05A-U1	241-BXR-153-L12
9456/9402	241-BX-106-06A-U1	241-BXR-153-L13
9470/9410	241-BX-104-04B-U2/04A-U1	241-BX-104-04A/241-BXR-153-L11
9625/9212	241-BXR-151-L11	241-BYR-152-U8
9625/9212	241-BXR-151-L11	241-BXR-152-U8
9653/141	221-B	Capped
9653/243	221-B	241-ER-151-L7
A101	241-AX-101	241-AX-152-A1
A102	241-AX-102	241-AX-152-A2
A-103	241-AX-103	241-AX-152-A3
A-104	241-AX-104	241-AX-152-A4
A4013	241-CR-152-3A	241-AX-151-Washdown
B101	241-AX-101	241-AX-152-B1
B102	241-AX-102	241-AX-152-B2
B-103	241-AX-103	241-AX-152-B3
B-104	241-AX-104	241-AX-152-B4
BWCTL	241-B-103-03A-C	241-B-106-06A-A
BWCTL-M2	241-B-102-02A-A	241-B-108-08A-C
C101	241-AX-101	241-AY-501
C102	241-AX-102	241-AY-501
C-103	241-AX-103	241-AY-501
C-104	241-AX-104	241-AY-501
D020	PUREX	241-A-151-U19
D040	PUREX	241-A-151-U19
D070	PUREX	241-A-151-U26
D088	PUREX	241-A-151-U25
D149	PUREX	241-A-151-U18
D186	PUREX	241-A-151-U5
D601D505	241-AZ-152	241-AY-152
E006	PUREX	241-A-151-U24
E167	PUREX	241-A-151-U23
F241	PUREX	241-A-151-U21
F274	PUREX	241-A-151-U9
F377	PUREX	241-A-151-U14
F429	PUREX	241-A-151-U13
F719	PUREX	241-A-151-U20
F791	PUREX	241-A-151-U8

Table H.2. Inactive/Not In-Use Facilities (Page 25 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
G057	PUREX	241-A-151-U17
G180	PUREX	241-A-151-U11
G212	PUREX	241-A-151-U16
M044	PUREX	241-A-151-U10
M045	PUREX	241-A-151-U22
R-165	PUREX	241-A-151-U12
R345	PUREX	241-A-151-U15
U039	PUREX	241-A-151-U6
U136	PUREX	241-A-151-U7
Drain	241-TX-101	241-TXR-152
Drain	241-TX-105-05D	241-TXR-153
Drain	241-TX-302A	241-TX-153
Drain	241-TX-302A	Crib
Drain	241-TX-302B	Encasement Drain
Drain	241-TX-302B	241-TX-155
Drain	241-TXR-244-002-Sump	241-TXR-151
Drain	241-TY-302A	241-TY-153
Drain	241-U-102-02A	P19 K1 Exhauster
Drain	241-U-102-02A-C	Clean Out Boxes-U32,33,34,35
Drain	241-U-105-05C-B	241-UA, 241-UB Flush Pits
Drain	241-U-105-05C-U1	241-UR-153
Drain	241-U-107-07A-B	Clean Out Box-U30,U31
Drain	241-U-107-07C	241-UR-154
Drain	241-U-108-08A-B	P-20 Exhauster
Drain	241-U-108-08A-C	Clean Out Box U-29
Drain	241-U-105-05C-C	241-U-A/241-U-B Flush Pits
Drain	241-U-111-11A-E	241-U-C/241-U-D Flush Pits
Drain	241-U-301-B	241-U-152
Drain (BX-302B)	241-BX-155	241-BX-302C
Drain Line	241-B-302B	241-B-154
Drain Line	241-BX-302B	241-BX-154
Drain Line	241-BYR-154	244-BXR Vault-002
Drain Line	241-C-102-02B-U3	241-C-Valve Pit-L1
Drain Line	241-C-103	241-C-Valve Pit
Drain Line	241-C-104-04C	241-CR-153
Drain Line	241-C-104-04B-U3	241-C-Valve Pit-L2
Drain Line	241-C-107-U1	241-C-Valve Pit-L3
Drain Line	241-C-252	Unknown Catch Tank
Drain Line	241-C-153 & 241-C-151	Unknown Catch Tank
Drain Line	241-S-102-02A-F	241-S-152
Drain Line	241-S-107	241-S-B Flush Pit
Drain Line	241-S-107	241-S-C Flush Pit
Drain Line	241-S-107	241-S-D Flush Pit

Table H.2. Inactive/Not In-Use Facilities (Page 26 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
Drain Line	241-S-302-B	241-S-302-A
Drain Line	244-CR-Tank-002	241-CR-151
Drain-301	241-C-106-06C-U8	To Metal Filter Drain
Drain-301	241-A Farm COBs	241-A-350
Drain 302	241-C-106-06C-U9	To Process Building Floor Drain
Drain 302	COB A-2	DR-301/241-A-350
Drain 303	COB A-5	DR-301/241-A-350
Drain 304	COB A-9	DR-301/241-A-350
Drain-305	241-A-B Flush Pit	DR-301/241-A-350
Drain-306	241-A-A Flush Pit	DR-301/241-A-350
Drain-307	241-A-A, A-B Flush Pits	241-A-350
Drain-308	COB A-3	DR-301/A-350
Drain-309	COB A-4	DR-301/A-350
Drain-314	241-AX-COBs	DR-301/A-350
Drain-315	COB A-10	DR-317/DR-301/241-A-350
Drain-316	COB A-8	DR-317/DR-301/241-A-350
Unknown	COB A-11	DR-317/DR-301/241-A-350
Drain-318	COB AX-12	DR314/241-AX-102 Riser 24
Drain-319	COB AX-14	DR314/241-AX-102 Riser 24
Drain-320	COB AX-15	DR314/241-AX-102 Riser 24
Drain-321	COB AX-16	DR314/241-AX-102 Riser 24
Drain-322	COB AX-17	DR314/241-AX-102 Riser 24
Drain-323	COB AX-18	DR314/DR370/241-AX-102 Riser 24
Drain-324	COB AX-21	DR314/DR370/241-AX-102 Riser 24
Drain-329	COB AX-19	DR314/DR370/241-AX-102 Riser 24
Drain-330	COB AX-24	DR325/241-AX-104 Riser 7C
Drain-331	COB AX-22	DR314/DR370/241-AX-102 Riser 24
Drain-332	COB AX-23	DR314/DR370/241-AX-102 Riser 24
Drain-341	C0B A-1	DR-301/241-A-350
Drain-342	C0B AX-26	DR333/DR325/241-AX-107 Riser 7C
Drain-347	C0B AX-20	DR325/DR307/241-AX-107 Riser 7C
Drain-348	C0B AX-25	DR333/DR325/241-AX-107 Riser 7C
Drain-349	COB AX-13	DR314/241-AX-102 Riser 24
Drain	241-BX-153 Drain	241-B-302A
Drain-0029	241-AX-153 Jumper Box	241-AX-152
CNDS-02	241-A-401 Condensate Bldg	241-A-401Diverter Caisson
CDNS-92	241-A-401 Condensate Bldg	241-A-401Diverter Caisson
CDNS-AN-02	241-A-401Diverter Caisson	241-AN-101-01D-B
CDNS-AN-92	241-A-401Diverter Caisson	241-AN-101-01D-A
Flush	241-UA-L6, L8, L17	241-UA Flush Pit
Flush	241-UB-R-17, R-8, R-6	241-UB Flush Pit
Flush	241-UC-L6, L8, L17	241-UC Flush Pit
Flush	241-UD-R6, R8, R17, R21	241-UD-Flush Pit/R-8

Table H.2. Inactive/Not In-Use Facilities (Page 27 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
Flush Line	241-A-A Flush Pit	241-A-A-L6, L8, L17
Flush line	241-A-B-Flush Pit	241-A-102-02B-4
Flush Line	241-A-B-R8, R6,R17	241-A-B Flush Pit
Flush Line	241-AX-A-L6,L8,L17	241-AX-A-Flush Pit
Flush Line	241-AX-B-R6,R8,R17	241-AX-B-Flush Pit
Flush Line	241-S-A-L8/L17	241-S-A Flush Pit
Flush Line	241-S-B-R6,R8,R17	241-S-B Flush Pit
Flush Line	241-S-C-L8,L17	241-S-C Flush Pit
Flush Line	241-S-D-R6,R8,R17	241-S-D Flush Pit
Flush Line	241-SX-A-L6,L17	241-SX-A Flush Pit
Flush Line	241-SX-A-R6,R17	241-SX-B Flush Pit
No number	241-UA-L18,L19	241-UB-R18,R19
Overflow	241-A-106 Sidewall	241-A-350 Sidewall
PL2021	242-B	241-B-106
PL-P11	241-BY-112-012D-5A	241-BY-109-09A-U6
PL-P22	241-BY-109	241-BY-108-08A-C
SL101	241-S-152-Nozzle 1	Blocked
SL101	241-UD-R3	Blocked
SL102	241-UC-L10	241-UA-L3
SL-102	241-A-106-06D-A	241-A-B-R7/COB A8,A9
SL104	241-U-109-09B-A	241-UC-L7
SL105	241-U-108-08B-A	241-UC-L9
SL-105	241-A-103-03D-A	241-A-B-R5
SL-106	241-A-B-R10	241-A-102-02D-A
SL108	241-U-107-07B-A	241-UD-R9
SL108	241-U-110-10B-A	241-UD-R7
SL109	241-U-103	241-U-B
SL110	241-U-06B	241-UA-L9
SL111	241-AX-103-03A-A	241-AX-A-L7
SL112	241-AX-104-04A-A	241-AX-B-R9
SL112	241-U-105-05B-A	241-U-A-L7
SL115	241-S-A	241-S-C
SL116	211-S-B-R10	241-S-D-R3
SL117	241-S-C	241-SX-A
SL118	241-S-D	241-SX-B
SL119	241-S-103-03A-B	241-S-A-L7
SL120	241-S-106-B	241-S-A-L9
SL-121	241-S-101-01A-B	241-S-B-R5
SL122	241-S-105-05A	241-S-B-R9
SL123	241-S-109-09A-B	241-S-C-L7
SL124	241-S-108-08A-B	241-S-C-L5

Table H.2. Inactive/Not In-Use Facilities (Page 28 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
SL125	241-S-112-12A-B	241-S-C-L9
SL126	241-S-D	None Identified
SL127	241-S-110-10A	241-S-D-R7
SL128	241-S-111-11A-B	241-S-D-R9
SL129	241-SX-103	241-SX-A
SL130	241-SX-102-02B-B	241-SX-A-L5
SL131	241-SX-106-06A-B	241-SX-151-L9
SL132	241-SX-105	241-SX-B-R9
SL133	241-SX-104-04A-B	241-SX-B-R7
SL134	241-S-A-L18	241-S-D-R18
SL137	241-SX-101-01A	241-SX-B-R5
SL138	241-S-152	242-S Evaporator
SL139	241-S-152-4	Capped
SL139/SL114	242-S Evaporator	241-S-B
SL175	241-S-152-8	Failed
SL175/S138	241-SY-A-L3	242-S Evaporator
SL176	241-S-152	Failed
SL204	241-U-109-09A-A	241-UC-L14
SL219	241-S-103-03A-A	241-S-A-L15
SN200	241-S-102	241-S-152-5
SN200	241-TX-116	244-TX-E
SN-200	241-BY-102-02A-U2	SN-200/Capped
SN201	241-S-102	241-S-152-7
SN201	241-TX-113-13A	SN206
SN-201	241-BY-103-U2	SN-200/Capped
SN202	241-UC-L12	241-UA-L1
SN-202	241-A-B-R11	241-A-106-06C-Nozzle A
SN-202	241-BY-105-05A-U2	SN-200/Capped
SN203	SN206	241-TX-105-05A
SN203	241-BY-106-06A-U2	SN200/Capped
SN205	241-U-108-08A-A	241-UC-L15
SN203	241-UC-R12	241-UB-R2
SN204	244-TX-D	241-TX-117-017A
SN-204	241-BY-108-08A-U1	SN207/Capped
SN205	SN204	241-TX-114-014A
SN-205	241-A-103-03C-A	241-A-B-R14
SN-205	241-BY-109-09A-U5	SN207/Capped
SN206	SN204	241-TX-110-01A
SN206	241-U-107-07A-A	241-UD-R14
SN-206	241-A-102-02C-3	241-A-102-02B-3
SN-206	241-BY-111-011A-U2	Capped
SN207	241-TX-106-06A	SN204

Table H.2. Inactive/Not In-Use Facilities (Page 29 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
SN207	251-U-111-11A-A	241-UD-R20
SN-207	241-A-A-L14	241-A-101-01B-A
SN-207	241-BY-103-03A	244-BX-D
SN-207	241-BY-112-012A	801
SN208	241-TX-118-18A	244-TX-C
SN-208	241-AX-101-01B-A	241-AX-A-L15
SN209	241-TX-115-15A	SN208
SN209	241-U-103-03A-A	241-UB-R-15
SN-209	241-AX-102-02D-A	241-AX-B-R14
SN210	241-TX-111-11A	SN208
SN210	241-U-106-06C-A	241-UA-L16
SN-210	241-AX-A-L19	241-AX-B-R19
SN211	241-AX-103-03D-A	241-AX-A-L14
SN-211	241-BY-110-010-A/BY-104-04-U2	244-BX-Nozzle B
SN211	241-U-102-02A-A	241-UB-R14
SN212	241-AX-104-04B-A	241-AX-B-R15
SN212	241-U-105-05C-A	241-UA-L14
SN212	241-TX-108-08A	SN211
SN213	241-S-102	241-S-A-L1
SN213	241-U-111-11A-C	241-UC-L15
SN211	241-TX-112-012A	244-TX-B
SN213	241-TX-101-01A	SN211
SN214	241-TX-102-02A	SN211
SN214	241-S-102	241-SB-R1
SN215	241-U-111-11A-B	241-UD-R15
SN215	241-TX-103-03A	SN211
SN215	241-S-A-L14	241-S-C-L1
SN216	241-S-152-9	Capped
SN216	241-S-B-R12	241-S-D-R1
SN216/217	241-BX-107/241-BX-110	244 BX-Nozzle E
SN217	241-S-C-L12	241-SX-A-L1
SN218	241-S-D-R12	241-SX-B-R1
SN220	241-S-106-06A-A	241-S-A-L16
SN221	241-S-101-01A-A	241-S-B-R14
SN222	241-S-105-05A	241-S-B-R16
SN223	241-S-109-09A-A	241-S-C-L15
SN224	241-S-108-08A-A	241-S-C-L14
SN225	241-S-112-12A-A	241-S-C-L16
SN226	241-S-107-07A-A	241-S-D-R14
SN227	241-S-110-10A	241-S-D-R15
SN228	241-S-111-11A-A	241-S-D-R16

Table H.2. Inactive/Not In-Use Facilities (Page 30 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
SN229	241-SX-103-03B-A	241-SX-A-L15
SN230	241-SX-102-02B-A	241-SX-A-L14
SN-230/215/214/213	241-BX-104-04B-U1	244-BX-Nozzle A
SN231	241-SX-106-06A-A	241-SX-A-L16
SN233	241-SX-104-04A-A	241-SX-B-R15
SN-235	241-A-102-02B-2	Capped off
SN239	241-S-C-L19	241-S-D-R19
SN241	241-SX-101-01A-A	241-SX-B-R14
SN242	241-S-102-02A-U6	241-S-A-L12
SN245	241-S-107-07A	244-S-18
SN246	241-S-107-07A	244-S-17
SN246	241-S-107-07A-B	241-S-D-R2
SN247	241-S-107-07A	244-S-16
SN248	241-S-107-07A	244-S-15
SN249	241-S-107-07A	244-S-14
SN249	244-TX-A	704
SN264	241-UD-R5	244-U-A
SN265	241-UD-R4	244-U-B
SN266	244-U-C	Capped
SN275	241-C-VP-U1,U2,U3,U4,U5,U6	244-CR-U15
SN281	241-S-152-10	Failed
SN282	241-S-152-11	Failed
SN-283	242-S Evaporator	241-SY-02E-A
SN-284	242-S Evaporator	241-SY-02E-B
7624	244-TX-I	241-T-111
7624	244-TX-I	244-T-109
Unk	244-AR-Tank001-T15	244-AR-Tank-004-T4
U039	PUREX	241-A-151-U6
U136	PUREX	241-A-151-U7
Unknown	241-A-104-04A-U1	241-A-101-01A-U1
Unknown	241-A-104-04A-U2	241-A-105-05C-A
Unknown	241-A-105-05A-U1	241-A-102-02A-U1
Unknown	241-A-106-06A-U1	241-A-103-03A-U1
Unknown	241-B-111	241-B-110
Unknown	241-B-112	241-B-111
Unknown	241-B-201	241-B-109
Unknown	241-BX-102	241-BX-101
Unknown	241-BX-103	241-BX-102

Table H.2. Inactive/Not In-Use Facilities (Page 31 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
Unknown	241-BY-106-06D, C	241-BY-109
Unknown	241-BY-112	241-BY-111
Unknown	241-C-101	241-C-102
Unknown	241-C-102	241-C-103
Unknown	241-C-101-01B-U1	8010
Unknown	241-C-102-02B-U2	Line 8006
Unknown	241-C-103-03B-U1	241-C-Valve Pit-L6
Unknown	241-C-103-03B-U2	Line 8002
Unknown	241-C-104-04B-U2	Line 8210
Unknown	241-C-104-04B-U3	241-C-Valve Pit-L2
Unknown	241-C-10505B-U3	Capped
Unknown	241-C-105-05B-U2	Line 8206
Unknown	241-C-106-06B-U2	Line 8202
Unknown	241-C-108	241-C-107
Unknown	241-C-109	241-C-108
Unknown	241-C-110-U1	241-C-Valve Pit-L3
Unknown	241-C-111	241-C-110
Unknown	241-C-112	241-C-111
Unknown	241-C-112	241-C-Valve Pit-L5
Unknown	241-S-102-BB/B	Flush Pit
Unknown	241-S-103	Clean Out Boxes-9, 10
Unknown	241-S-109	Clean Out Boxes-13, 14
Unknown	241-S-A-L19	241-S-B-R19
Unknown	241-S-C-L18	241-S-D-R18
Unknown	241-SX-106	Clean Out Boxes-24, 25
Unknown	241-SX-A-L18	241-SX-B-R18
Unknown	241-SX-A-L19	241-SX-B-R19
Unknown	241-T-101	241-T-102
Unknown	241-T-101	241-T-102-02B-U3
Unknown	241-T-101-01B-U2	6010
Unknown	241-T-101-01B-U3	241-T-105
Unknown	241-T-102	241-T-103
Unknown	241-T-102-02B-U2	6006
Unknown	241-T-103-03B-U2	6002
Unknown	241-T-104	241-T-105
Unknown	241-T-105	241-T-106
Unknown	241-T-107	241-T-108
Unknown	241-T-108	241-T-109
Unknown	241-T-110	241-T-111
Unknown	241-T-111	241-T-112
Unknown	241-TX-117	241-TX-118
Unknown	241-T-201	241-T-101

Table H.2. Inactive/Not In-Use Facilities (Page 32 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
Unknown	241-T-202	241-T-101
Unknown	241-T-203	241-T-101
Unknown	241-T-204	241-T-101
Unknown	241-TX-105	241-TX-106
Unknown	241-TX-106-06A-D	241-TX-107-07A-C
Unknown	241-TX-107	241-TX-108
Unknown	241-TX-109	241-TX-110
Unknown	241-TX-109-09A-C	241-TX-05A-A
Unknown	241-TX-110	241-TX-111
Unknown	241-TX-110A-A	241-TX-106-06A-C
Unknown	241-TX-111	241-TX-112
Unknown	241-TX-113	241-TX-114-14A
Unknown	241-TX-113	241-TX-114
Unknown	241-TX-114	241-TX-115
Unknown	241-TX-115	15-X (V615)
Unknown	241-TX-116	241-TX-117
Unknown	241-TX-117	241-TX-118
Unknown	241-TXR-244-Tank-002	241-TXR-244-U1-Tank-001
Unknown	241-TXR-244-Tank-003	241-TXR-244-U2-Tank-001
Unknown	241-TY-101	241-TY-102
Unknown	241-TY-103	241-TY-104
Unknown	241-TY-103-03A-A	241-TY-103-C
Unknown	241-TY-105	241-TY-106
Unknown	242-TA	242-T
Unknown	241-UA-L18	241-UB-R-18
Unknown	241-UA-L19	241-UB-R19
Unknown	241-UC-L18	241-UD-R18
Unknown	241-UC-L19	241-UD-R19
Unknown	241-UX-302A	291-U Stack
Unknown	242-B	241-B-106
Unknown	242-S Evaporator	241-S-103
Unknown	244-BXR-Tank-002-U2	244-BXR-011
Unknown (02C)	241-A-102-02C-U1	241-A-153-L8
V004	241-A-152-U2	241-A-151-L22
V005	241-A-152-U8	241-A-151-L21
V006	241-A-152-U4	241-A-151-L20
V007	241-A-152-U6	241-A-151-L17,L18,L19
V008	241-A-152-U10	241-A-151-L14,L15,L16
V-011	241-A-151-L7,L9	Crib
V-014	241-A-151-L5,L6,L11,L12	Tank 216A
V-016	241-A-151-L3,L4,L10	Crib

Table H.2. Inactive/Not In-Use Facilities (Page 33 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V021	241-A-151-L25	241-AW-A-L12
V022	241-A-151-L-24	241-AW-B-R12
V023	241-A-151-L23	241-AW-B-R11
V029	241-A-151-UC	241-A-151-UD
V031	241-A-151-UA	241-A-151-UF
V032	241-A-106-A-U1/103-03A-U1	241-A-152-U7
V038	241-A-152-L6	241-A-101
V039	241-A-152-L5	241-A-101
V040	241-A-152-L4	241-A-102
V041	241-A-152-L3	241-A-102
V042	241-A-103	241-A-152-L2
V043	241-A-103	241-A-152-L1
V044	241-A-152-L10	241-A-104
V045	241-A-152-L11	241-A-104
V046	241-A-152-L12	241-A-105
V047	241-A-152-L13	241-A-105
V048	241-A-106	241-A-152-L14
V049	241-A-106	241-A-152-L15
V050	241-A-152-L7	241-C-104
V051	241-A-152-L8	241-C-104
V052	241-A-152-L9	Capped
V058	241-A-152-A	241-A-152-A
V059	241-A-152-B	241-A-152-B
V060	241-A-152-C	241-A-302B/241-A-152-C
V061	241-A-152-L16	Capped
V100	241-C-151-L1	241-C-153-U9
V1000	241-CR-152	244-CR Vault-U14
V1001	241-CR-152-U4A	241-CR-153-U3A
V1002	241-CR-152-U6A	241-CR-153-U1A
V101	241-C-153	Capped
V101	241-C-151-L2	241-C-104-04A-U4
V102	241-C-101	241-C-151-L4
V103	241-C-105	241-C-151-L3
V104	241-C-101	241-C-151-L5
V105/8636	241-C-151-L6	241-CR-151-U1
V107	241-C-252-U4	241-C-151-L8
V108/812	241-C-151-U1	244-AR-Tank-002-T9
V109	241-C-151-U2	241-A-101
V110	241-C-151-U3	244-CR Vault-U12
V113	241-C-151	241-AX-101-01A
V113	241-C-151	241-AX-103-03A-1
V115	241-C-105-05A-U8	241-C-152-L1
V118	241-C-152-L4	241-C-153-U6

Table H.2. Inactive/Not In-Use Facilities (Page 34 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V119	241-C-152-L5	241-C-153-U5
V120	241-C-152-L6	241-C-153-U4
V121	241-C-152	Capped
V122	241-C-105-05A-U4	241-C-152-L8
V130	241-B-154-L8	241-C-152-U4
V136	241-C-153-L1	None Identified
V137	241-C-153-L2	241-C-110
V138	241-C-110	241-C-153-L3
V139	241-C-110	241-C-153-L4
V140	241-C-110	241-C-153-L5
V141	241-C-153-L6	Capped
V142	241-C-153-L7	Capped
V143	241-C-107	241-C-153-L8
V144	241-C-107	241-C-153-L9
V145	241-C-107	241-C-153-L10
V147	241-C-153-L1`2	None Identified
V148	241-C-104	241-C-153-L13
V149	241-C-104	241-C-153-L14
V150	241-C-104	241-C-153-L15
V156	241-C-201	241-C-252-L1
V157	241-C-201	241-C-252-L2
V158	241-C-202	241-C-252-L3
V159	241-C-202	241-C-252-L4
V160	241-C-203	241-C-252-L5
V161	241-C-203	241-C-252-L6
V162	241-C-204	241-C-252-L7
V163	241-C-204	241-C-252-L8
V172	241-C-252-U1	241-C-109/241-C-112
V175	241-C-252-U5	201-C Hot Semi Works
V200	241-B-154-U7	221-B
V2000	241-BXR-152-U1A	241-BX-155-L9
V2001	241-BX-155-L10	241-BR-152-U1A
V201	241-B-154-U8	241-B-302B Catch Tank
V203	241-B-154-L2	Crib
V204	241-B-154-L3	Sump
V208	241-B-154-L7	241-B-152-U6
V209	241-B-154-L9	241-B-152-U5
V210/V111	241-B-154-L10	241-C-151-U4
V211	241-B-154-L11	241-B-152-U4
V213	241-B-154-L13	241-B-151-U4
V214/8902	241-B-154-L14	221-B
V215	241-B-154-L15	241-B-151-U3

Table H.2. Inactive/Not In-Use Facilities (Page 35 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V219	241-ER-151-L2	Capped
V225	241-B-151-U1	241-ER-151-L10
V228	241-CR-153-U6A	241-ER-153-7
V230	241-B-153-U1	241-B-151-L1
V231	241-B-153-U8	241-B-151-L2
V233	241-B-151-L4	241-B-101
V234	241-B-151-L5	241-B-101
V235	241-BX-153-U3	241-B-151-L6
V236	241-BX-153-U11	241-B-151-L7
V237	241-B-151-L8	241-BX-101
V238	241-B-151/B-153/B-252 Drains	241-B-301B Catch Tank
V240	241-B-152-U3	241-B-151-U5
V242	241-BX-153-U4	241-B-152-L1
V243	241-V-252-U6	241-B-152-L2
V244	244-CR Vault	241-ER-153
V245	241-B-153-U6	241-B-153-L4
V246	241-B-153-U5	241-B-152-L5
V247	241-B-153-U4	241-B-153-L6
V250	241-B-152-L11	241-B-106
V252	241-BX-153-U6	241-B-152-L11
V253	241-BX-153-U5	241-B-152
V260	241-B-153-L2	241-B-111
V261	241-B-153-L3	241-B-110
V262	241-B-153-L4	241-B-110
V263	241-B-153-L5	241-B-110
V266	241-B-153-L8	241-B-107
V267	241-B-153-L9	241-B-107
V268	241-B-153-L10	241-B-107
V271	241-B-153-L13	241-B-104
V272	241-B-153-L14	241-B-104
V273	241-B-153-L15	241-B-104
V282	241-BX-155-U2	241-BX-154-L3
V283	241-BX-155-U3	241-BX-154-L4
V284	241-BX-155-U4	241-BX-154-L5
V285	241-BX-154-L6	241-B-252-U5
V289	241-BX-154-U9	241-BX-302B
V290	241-BX-201	241-B-252-L1
V291	241-BX-201	241-B-252-L2
V292	241-BX-202	241-B-252-L3
V293	241-BX-202	241-B-252-L4
V294	241-BX-203	241-B-252-L5
V295	241-BX-203	241-B-252-L6
V296	241-BX-204	241-B-252-L7

Table H.2. Inactive/Not In-Use Facilities (Page 36 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V297	241-BX-204	241-B-252-L8
V305	241-B-252-L16	241-BY-109
V307	242-B-151-L1	241-B-108
V308	242-B-151-L2	241-B-109
V309	242-B-151-L3	241-B-107
V310	242-B-151-L4	241-B-105
V311	242-B-151-L5	241-B-104
V312	241-B-104	241-B-151-Drain
V313	242-B-151-U1	242-B Evaporator
V314	242-B Evaporator	Cut and Capped
V315	241-BX-155-L2	241-B-151-U6
V316	241-BX-153-U9	241-BX-155-L3
V317	241-BX-153-U8	241-BX-155-L4
V318	241-BX-153-U7	241-BX-155-L5
V319	241-BX-155-L6	241-B-152-U2
V323	241-BX-155-U7	241-BX-302C
V329	241-B-154-U1	221-B
V330	241-B-154-U2	221-B
V331	241-B-154-U3	221-B
V332	241-B-154-U4	221-B
V333	241-B-154-U5	221-B
V334	241-B-154-U6	221-B
V335	221-B	241-BX-154-U1
V336	241-BX-154-U2	221-B
V337	241-BX-154-U3	221-B
V338	241-BX-153-U12	241-B-302A
V339	241-BX-154-U5	221-B
V340	241-BX-154-U6	221-B
V341	241-BX-154-U7	221-B
V342	241-BX-110	241-BX-153-L4
V342	241-BX-154-U8	221-B
V343	241-BX-110	241-BX-153-L5
V344	241-BX-110	241-BX-153-L6
V345	241-BX-109	241-BX-153-L11
V346	241-BX-107	241-BX-153-L8
V347	241-BX-107	241-BX-153-L9
V348	241-BX-107	241-BX-153-L10
V349	241-BY-104	241-BX-153-L12
V350	241-BX-112	241-BX-153-L7
V351	241-BX-104	241-BX-153-L13
V352	241-BX-104	241-BX-153-L14
V353	241-BX-104	241-BX-153-L15

Table H.2. Inactive/Not In-Use Facilities (Page 37 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V355	241-BX-101	241-BX-153-L17
V365	241-ER-151-U8	Flow meter Box
V374	241-UX-154-U6	221-U
V375	241-UX-154-U9	241-TX-155-U17
V376	241-UX-154-U10	241-TX-155-U15
V382	241-UX-154-L3	241-TX-155-U11
V383	241-TX-154-L7	Capped
V384	241-TX-154-7	Capped
V385	241-TX-154-L7	Capped
V386	241-TX-155-L8	Capped
V388	241-TX-155-U12	Capped
V391	241-TX-154-L3	241-TX-155-U16
V392	241-TX-154-L2	241-TX-155-U18
V393	241-TX-302B	241-TX-155-U19
V394	241-TX-155-A1	241-TX-155-A2
V395	241-TX-155-B1	241-TX-155-B2
V396	241-TX-155-L2	241-TX-153-U15
V397	241-TX-155-L4	241-TX-153-U14
V399	241-T-152-U7	241-TX-155-U6
V401	241-TX-155-L8	241-TX-153-U12
V402	3241-TX-155-L9	Capped
V403	241-TX-155-L10	241-TX-153-U11
V405	241-T-152-U3	241-TX-155-L12
V406	241-TX-155-L13	Capped
V407	241-TX-155-L14	241-TX-153-U6
V487	241-U-201	241-U-252-L1
V408	241-TX-155-L15	Capped
V408	244-TX-0	241-TX-152 Drain
V409	241-TX-155-L16	241-TX-153-U4
V410	241-TX-155-L17	Capped
V410	241-U-151-U2	241-TX-155-L17
V411	241-T-151-U2	241-TX-155-L18
V412	241-TX-155-L19	Blocked
V413	241-TX-155-L20	241-TX-153-U3
V416	241-U-152-U1	241-TX-153-U10
V426	241-U-152-L4	241-U-153-U6
V427	241-U-152-L5	241-U-153-U5
V428/V461	241-U-152-L6	241-U-153-U4
V450	241-U-153-U9	241-U-151-L1
V445	241-U-151-U1	241-T-151-L6
V458	241-U-153-U1	240-S-151-L9
V459	241-U-153-U2	240-S-151-L15

Table H.2. Inactive/Not In-Use Facilities (Page 38 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V460	241-U-153-U3	240-S-151
V465	241-U-153-L3	241-U-110
V466	241-U-153-L4	241-U-110
V467	241-U-153-L5	241-U-110
V470	241-U-153-L8	241-U-107
V471	241-U-153-L9	241-U-107
V472	241-U-153-L10	241-U-107
V473/5107/5507/5307	241-U-153-L11	241-UR-154-L8/-UR-153-L8/UR-152-L8
V488	241-U-201	241-U-252-L2
V489	241-U-202	241-U-252-L3
V490	241-U-202	241-U-252-L4
V491	241-U-203	241-U-252-L5
V492	241-U-203	241-U-252-L6
V493	241-U-204	241-U-252-L7
V494	241-U-204	241-U-252-L8
V5006	241-S-104-04A	241-S-107-07A
V508	240-S-151-L17	241-S-151-U6
V509	240-S-151-L16	241-S-151-U7
V512	240-S-151-L13	241-S-151-U10
V513	240-S-151-L12	241-S-151-U11
V514	240-S-151-L6/241S-151-U12	Capped
V515	240-S-151-L9	241-S-151-U14
V516	240-S-151-L7	241-S-151-U15
V517	240-S-151-L5	Capped
V517	241-S-151-U16	Redox Lab Waste
V519	240-S-151-L2	241-S-151-U18
V526	241-SX-151-U13	241-S-151-L4
V527	241-SX-151-U10	241-S-151-L5
V528	241-SX-151-U8	241-S-151-L6
V529	241-SX-151-U6	241-S-151-L7
V530	241-SX-151-U4	241-S-151-L5
V533	241-S-151-L11	Crib
V534	241-S-110	241-S-151-L12
V535	241-S-110	241-S-151-L13
V536	241-S-107	241-S-151-L14
V537	241-S-107	241-S-151-L15
V538	241-S-104	241-S-151-L16
V539	241-S-104	241-S-151-L17
V541	241-S-101/101 S Caisson	241-S-151-L19
V542	241-S-304	241-S-151
V543	241-S-304	241-S-151

Table H.2. Inactive/Not In-Use Facilities (Page 39 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V544	240-S-151-L1	216-S Swamp
V547	240-S-151-L8	216-S Crib
V548	240-S-151-L10	V544/216 S Swamp
V550	240-S-151	V544/216-S Swamp
V552	240-S-151-U3	240-S-152-L2
V553	240-S-151-U8	240-S-142-L3
V554	240-S-151-L12	241-S-302-CT
V555	240-S-152-L1	240-S-151-U17
V563	241-SX-151-U1	241S-302A
V564	241-SX-151-U11	241-SX-151-U2
V566	241-SX-151-U9	241-SX-151-U5
V567/V581	241-SX-151-U7	241-SX-152
V569	241-SX-302-A	241-SX-151-L1
V570	241-SX-110	241-SX-151-L2
V571	241-SX-111	241-SX-151-L2
V572	241-SX-112	241-SX-151-L4
V574	241-SX-109	241-SX-151-L6
V575	241-SX-108	241-SX-151-L7
V576	241-SX-107	241-SX-151-L8
V577	241-SX-151-L9	241-SX-152
V578	241-SX-101	241-SX-151-L10
V579	241-SX-102	241-SX-151-L11
V580	241-SX-103-03	241-SX-151-L12
V582	241-SX-106	241-SX-151-L14
V583	241-SX-105	241-SX-151-L15
V584	241-SX-104	241-SX-151-L16
V591	241-SX-114	241-SX-151-L23
V595	241-SX-302-A	241-SX-152
V596	241-TX-153-U1	241-TX-302A
V597	241-TY-153-L1	241-TX-153-U2
V600	241-TXR-152-U14	241-TXR-153-U14/241-TX-153-U8
V6002	241-TR-152-U13	241-T-103-03A-U1
V6006	241-TR-152-U12	241-T-102-02A-U1
V601	241-T-152-L10	241-TX-153-U9
V6010	241-TR-152-L11	241-T-101-01A-U1
V603	241-TX-153-A1	241-TX-153-A2
V604	241-TX-153-B1	241-TX-153-B2
V606	241-TX-153-C2	219-1 Crib
V608	241-TX-101	241-TX-153-L2
V609	241-TX-101	241-TX-153-L3
V610	241-TX-153-L4	242-T Evaporator

Table H.2. Inactive/Not In-Use Facilities (Page 40 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V612	241-TX-105	241-TX-153-L6
V613	241-TX-105	241-TX-153-L7
V615	241-TX-115/15-X	241-TX-153-L9
V616	241-TX-118	241-TX-153-L10
V617	241-TX-107	241-TX-153-L11
V618	241-TX-109	241-TX-153-L12
V619	241-TX-109	241-TX-153-L13
V621	241-TX-113	241-TX-153-L15
V622	241-TX-113	241-TX-153-L16
V625	241-TX-116	241-TX-153-L19
V644	241-TY-103	241-TY-153-L7
V645	241-TY-103	241-TY-153-L8
V648	241-TY-101	241-TY-153-L11
V649	241-TY-101	241-TY-153-L12
V653	241-T-151-U3	221-T
V654	241-T-151-U4	221-T
V657	241-T-151-L1	241-T-153-U1
V658	241-T-151-L2	241-T-153-U8
V660	241-T-101	241-T-151-L4
V661	241-T-101	241-T-151-L5
V663	241-T-151-L8	Crib
V664	241-T-151/241-T-152/241-T-153	241-T-302B
V667	241-T-152-U4	221-T
V668	241-T-152-U5	221-T
V669	241-T-152-U6	221-T
V671	241-T-152-U9	224-T
V675	241-T-153-U5	241-T-152-U4
V676	241-T-153-U6	241-T-152-U5
V677	241-T-152-L6	241-T-153-U4
V690	241-T-110	241-T-153-L2
V691	241-T-110	241-T-153-L4
V692	241-T-110	241-T-153-L5
V695	241-T-107	241-T-153-L8
V696	241-T-107	241-T-153-L9
V697	241-T-107	241-T-153-L10
V698	241-T-106	241-T-153-L11
V699	241-T-105	241-T-153-L12
V700	241-T-104	241-T-153-L13
V701	241-T-104	241-T-153-L14
V702	241-T-104	241-T-153-L15
V707	221-T-Section 10	Unknown

Table H.2. Inactive/Not In-Use Facilities (Page 41 of 41)

I. Transfer Lines (Continued)

Line Number	Connecting Facility	Connecting Facility
V711	241-T-201	241-T-252-L1
V712	241-T-201	241-T-252-L2
V713	241-T-202	241-T-252-L3
V714	241-T-202	241-T-252-L4
V714	PUREX-F16	241-AR-151-2
V715	241-T-203	241-T-252-L5
V716	241-T-203	241-T-252-L6
V716	241-U-301-B	244-U Vault-E
V717	241-T-204	241-T-252-L7
V718	241-T-204	241-T-252-L8
V718/817	241-AR-151-10	244-AR Vault-T-15
V727	241-T-301-B	241-T-252 Drain
V730	221-T	241-TX-154-U1
V732	221-T	241-TX-154-U2
V734	221-T	241-TX-154-U4
V735	221-T	241-TX-154-U5
V736	241-TX-154-L6	291-5 STACK
V737	221-T	241-TX-154-U7
V738	221-T	241-TX-154-U8
V739	241-TX-154-U9	241-TX-302C Catch Tank
V743	221-B	241-C-154
V762/4853	241-SX-152	241-UX-154-L9
V827	241-TX-113	241-T-151-L2
V831	241-TX-114/TX-14B Valve Pit	242-T-151-L1
V839	241-C-154	201-C Hot Semi Works
V843	241-C-102	241-CR-151-L9
V844	241-C-102	241-CR-151-L8

This page intentionally left blank.